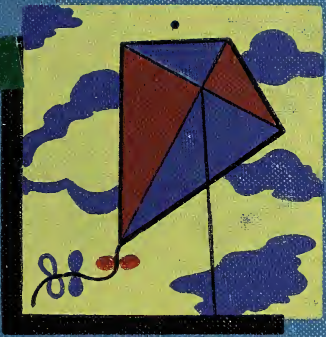
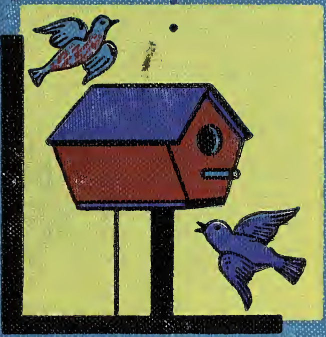
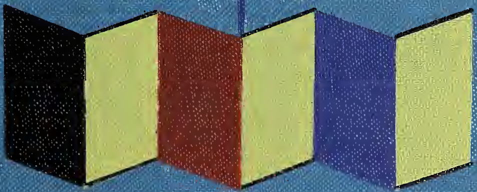
EXPLORING SCIENCE
Two

THURBER







CURRICULUM

Teachers' Edition

Ex libris
universitatis
albertaensis

UNIVERSITY OF ALBERTA
QUAECUMQUE VERA

34-4% kids

30 - 44 teachers.

Teachers' Manual for

EXPLORING SCIENCE

Two

by **Walter A. Thurber**

Professor of Science
Cortland State Teachers College
Cortland, New York

Edited by **Paul E. Smith**

THE MACMILLAN COMPANY
OF CANADA LIMITED
TORONTO

Revised Canadian Edition

Copyright, 1957

THE MACMILLAN COMPANY OF CANADA LIMITED

Printed in Canada

Originally published by
ALLYN AND BACON, INC.

UNIVERSITY
OF ALBERTA LIBRARY

Contents

Introduction 5

- *Putting Science in the Curriculum* 5
- *How to Use the Books* 8
- *Special Techniques for Teaching Science* 12
- *Conservation Education* 16
- *Health and Safety Education* 17

Detailed Teaching Suggestions for Book Two 19

- *Word List* 20
- Grasshoppers 25
- Watching the Sky 32
- The Thermometer 38
- The Pull of the Earth 44
- When We Run and Play 49
- Mirrors 56
- Fun with a Dry Cell 62
- Buds 67
- Rust 73
- Moving Things More Easily 78
- Birds' Eggs 83
- Wind 89

List of Science Materials 94

General References for the Teacher 96

416347

Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

https://archive.org/details/exploringsciencethur_0

Introduction

PUTTING SCIENCE IN THE CURRICULUM

"Learn through doing!" "Study things—not ideas!" What excellent precepts for a science programme! For children love to "do" more than they care to sit passively. And they learn best when they are using their senses to study the world about them.

Imagine a cheerful classroom with children taking care of radish seedlings and goldfish; with children keeping records of tadpole growth and weather changes; with children making model boats and cricket cages; with children comparing what books say about robins with their own observations; with children experimenting, arguing about results, and suggesting new ways to prove that there is water in the air.

This is a picture of a science programme that is meant for children. These children are learning more than isolated facts; they are learning to work together, to solve problems, to handle tools, to use books. And they love every moment of it!

Teaching like this is fun. The outcomes are highly satisfying. Children need only the ideas for things to do, a little help in finding materials, and some encouragement. They supply the necessary enthusiasm and energy.

Some Reasons for Elementary Science

The elementary school is concerned with the growth of the child, —his intellectual, social, emotional, and physical growth. All subject-matter areas have the same general objectives, but they use different methods and content for attaining them. Science, because it deals so much with tangible things, makes several unique contributions.

Much of the programme of the Exploring Science Series involves manipulation, thus developing muscular co-ordination, skill with tools, and familiarity with materials. A number of otherwise outstanding pupils are seriously deficient in manipulative ability, this phase of their education having been neglected. They benefit greatly from opportunities to work with the "things" of the science programme. In contrast, there are a number of retarded readers who find in this phase of science their only opportunities to equal or excel their classmates.

A rich variety of science projects gives all children opportunities for self-expression. Some children best express themselves by making models; some through making friezes, charts, and posters, some by writing science stories, keeping notebooks, and producing science plays; some through collecting and exhibiting.

Science activities encourage pupils to plan, to use ingenuity, and to exercise initiative. When the activities are carried out by small groups, the pupils learn to plan and work together, to share responsibilities, and to assume leadership.

Experiments, field trips, projects, and similar activities stimulate pupils to turn to books for information. By comparing what authorities say with their own observations, the pupils tend to become more critical and they develop habits of open-mindedness and delayed judgment.

Certain phases of the subject matter of science have immediate and important values. Especially important are the learnings that contribute to establishing better health and safety practices. A large share of health and safety education is based upon scientific information. Another area that benefits from science subject matter is conservation education; so closely is conservation allied with science that the two are usually included in the same programme. (Pages 16–18 of this Teachers' Edition discuss the role of science in conservation and health and safety education.)

How Much Time for Science?

"Can you afford fifteen minutes three times a week for science?" This in answer to teachers who are concerned about the already crowded class curriculum. Successful science programmes have been carried out with as little time as this scheduled for science class work. More time is to be desired, but there need be no sacrifice of other important areas when science is added to the school programme.

An elementary science programme does not demand a great deal of formal class time to keep it progressing satisfactorily. Three or four short periods weekly, or the equivalent, are adequate for pupil motivation, with much of the actual science work being carried on outside class time. Most of the units in the Exploring Science Series require two or three weeks for satisfactory development—for planning, experimenting, and discussing.

Science does not require much class time because children make time for science. They find the work too exciting to be dropped between lessons. They rush to school in the morning to see how their plants and animals have fared through the night. They use much of their free time during the school day for science activities. If permitted they will stay after school to work with science materials. And it is not unusual for a majority of the pupils to repeat at home the experiments they have carried out during their science lessons.

It is possible to make science the core of the entire school programme; many children prefer to make science just that. Many children prefer to talk and write about science for their language work; many prefer to read about science during reading periods; some prefer to base their art work on science subjects. As one teacher put it, "I have learned how to start a science programme. Now show me how to stop it!"

Planned and Incidental Science

A planned programme ensures steady progress from grade to grade with a minimum of overlapping and repetition. A planned programme ensures breadth of content and a balance among the various subject-matter areas of science.

A planned programme gives point and direction to the work of the pupils and keeps their enthusiasm high. It opens up new avenues for exploration. Without planning, science programmes usually become haphazard and are sometimes neglected.

On the other hand, there should be time available for what is called "incidental" science. Pupils should have an opportunity to watch a butterfly that has just emerged or to study a rainbow that has just appeared in the sky. Incidental science deals with the unexpected; it is often responsible for some of the most worth-while outcomes of the science programme.

Equipment for the Science Programme

Mayonnaise jars, tin cans, paper clips, and soda straws—such are the materials needed for a science programme. There is nothing mysterious about these commonplace materials. When a child does an experiment with a mayonnaise jar he is working with something familiar to him. He can repeat the experiment at home if he wishes. To him, science is the study of familiar things.

A list of materials needed for each unit of the Exploring Science Series is included in the specific suggestions for teaching each unit. A list of all the science materials needed for the year's programme is included at the end of this Teachers' Edition. Children can supply most of the items, such as tin cans and glass jars. Some of these should be stocked in quantities so that there is always a supply on hand.

It is well to make a list of materials that children cannot bring in. This list may include such raw materials as soft pine lumber, wire, nails, and screws. The list should then be discussed with the principal or the supervisor for items that can be supplied by special departments of the school system. Usually only a few items need be purchased separately.

Ideally, materials for an activity programme should be provided in quantity. Instead of a single hand lens, a class of thirty children should have at least fifteen hand lenses. Although this may seem prohibitively expensive it need not be so. Other teachers in the school will probably be able to use the same materials. By providing a central storage space, and by working out a schedule for the use of the materials, the per-pupil cost becomes insignificant.

HOW TO USE THE BOOKS

Each pair of facing pages in the books of the Exploring Science Series sets the stage for an exciting adventure in science—an experiment, a demonstration, a field trip, a class project. The books are study guides rather than science readers. They present a programme to the pupils and show them how to carry it out.

Some teachers may choose to follow the books page by page, deviating little from the programme as it is presented. Their classes will be meaningful and fun for the pupils.

Other teachers will prefer to modify the programme to fit their special needs. Each book has been planned to permit a high degree of flexibility. How to take advantage of this flexibility and other features are discussed below.

How the Books are Organized

Science experiences form the basis for the Exploring Science Series. Emphasis is upon first-hand experience activities supplemented by information given through pictures and reading.

The activities have been selected to provide experiences in all the common areas of science, both physical and biological. This presents a well-rounded programme that appeals to different interests and gives a broad background in science.

The activities are grouped in units centred about such familiar subjects as "Mirrors" and "Sunshine" rather than in units of formalized science. A single unit can, and often does, cut across several conventional subject-matter areas.

The material of a unit is developed in two-page blocks, each of which usually takes up a separate topic. This is a successful pattern often found in how-to-do-it books. It is useful in these science books because pupils can carry out an activity without turning pages.

The Teachers' Editions

The special Teachers' Editions for the Exploring Science Series contain the material given in the pupils' editions together with detailed suggestions for using this material.

Each unit is introduced with a discussion of the possible outcomes of the unit and a description of the part the unit plays in the entire science programme. Necessary materials are listed. Different methods of developing and enriching the unit are suggested, and valuable background information is provided.

Following these general helps, the material in the unit is considered page by page. Different methods of developing lessons are suggested. There is advice about the use of tools and materials. Possible difficulties are anticipated, and suggested things for the teacher to say in the classroom are in bold-face type. Answers to questions pupils might ask, follow-up activities, and references are listed. See PREPARING FOR THE UNIT for the best time to begin a unit.

The Teachers' Editions give teachers confidence in their ability to teach science. The Teachers' Editions help teachers to take full advantage of the special features of the books, thus providing a rich and challenging programme.

Scheduling Science

Most of the units in the Exploring Science Series require two or three weeks for satisfactory development. Children should not be hurried through a science programme. They need time to experiment, to discuss results, to try experiments again. They need time between lessons, too. A pupil who has connected a dry cell to an electric lamp during a science lesson will want to repeat the experience during his free time. He may also wish to repeat the experience at home.

Most of the two-page blocks of a unit serve as the subject for one or more lessons each. One of these blocks may describe an activity that requires a full lesson for completion. Some of the activities may be started in one lesson, as with many experiments with plants, and then finished during a lesson at a later time. Field trips require additional lessons for preparation and for follow-up. Projects usually require several lesson periods.

It is recommended that the minimum time allotment for science be scheduled as lesson periods. Additional time can be used for incidental science or for extending scheduled lesson periods as needed.

There are several ways to provide additional science time without scheduling it at the expense of other subjects. If there is a "science table" at the side of the room, materials may be placed on it for pupils to use in their free time, both in and out of school hours. Individual projects can be started in school and completed at home. There can be correlation with reading, language, art, and social studies. As long as the science programme is interesting, the pupils will find time for it.

Modifying the Basic Programme

Perhaps spring comes early to your section of the country. Perhaps your community makes much of Fire Prevention Week. The teaching calendar should recognize these and other important events. The flexibility of the Exploring Science Series makes it possible to shift units as desired because the units within a book are independent of each other. A unit involving fire can be moved to early fall, and a unit involving spring can be scheduled for the time when daffodils burst from the ground.

Likewise the material within a unit may be reorganized to take advantage of special conditions. Rearrangement of the two-page blocks may permit a more suitable activity to open a unit. Additional activities can be inserted as desired. One may also delete some of the activities that do not seem appropriate to the teaching situation.

The class may wish to take up science material that is not included in the programme of the books. This is admirable and the class should be given every encouragement. There are a few cautions that should be observed. The teacher should be sure that the subject is of interest to all pupils and not to just a few of the more aggressive individuals. She should be sure that there are suitable activities to be used in teaching the proposed subject. She should try not to take up material that will be taught by teachers in later grades. If pupils suggest a topic that does not seem suitable for the entire class, the topic may be assigned to certain interested pupils as optional work. Assigning a particular topic to a superior child will frequently reawaken his interest by confronting him with a real challenge to his ability.

Beginning a Unit

To start children thinking about magnets put magnets in their hands. To start them thinking about frogs put a frog where they can watch it. That is all there is to starting a new unit.

New materials may be presented in several ways. Sometimes, as with magnets, the materials may be put in the hands of the pupils with little explanation. Sometimes an interesting demonstration can be used; for example, a "race" with burning candles under various-sized jars to see which candle goes out first. Living things, particularly things that move, need only be placed where pupils can watch them.

Special days and special events offer possibilities for introducing new topics. A St. Patrick's Day carnation raises questions that lead to experiments with water movement in plants. Coloured Easter eggs raise questions about dyes that lead to experiments with dyeing cloth.

First-hand experiences make the most interesting and the most challenging approaches to new units. There can be no one best approach to a unit because conditions vary so much, but a little imagination adapts most activities to meet the situation.

Developing a Unit

The pattern in which the material is presented in the Exploring Science Series is one that has been used successfully, but it is not necessarily the most satisfactory for a particular situation. There can be no one best pattern: much depends upon the interests of the pupils, upon the teaching situation, and upon unpredictable events. A teacher should feel free to modify any unit—rearranging the topics, adding material, and deleting material.

It is important that there be variety in a unit. Variety keeps interest high and provides for individual differences. Use experiments, field trips, demonstrations, model-making, and science play-writing, to obtain the necessary variety.

Different types of activities make different contributions to a science programme. Experiments and field trips provide the basic first-hand information. Study of books and pictures supplements first-hand information with information that has been gained by other people in different situations. Model-making, play-writing, and similar activities serve to organize information.

These books make use of many different types of activities in the development of the programme. The detailed sections of these Teachers' Editions suggest still more types of activities that can be used to enrich the programme.

Evaluating Outcomes

As yet, no one has discovered how to measure the truly important outcomes of a science programme. Certainly the facts of science as tested by pencil-and-paper tests are of small consequence. The important outcomes are the attitudes that pupils develop, the skills they gain, and the habits they acquire.

Evaluation of the effectiveness of a science programme is chiefly one of personal judgment. One must depend upon many small but significant signs. One may look for signs of general interest. How many pupils participated in each activity? How many children volunteered for optional activities? How many pupils brought in materials when asked to do so? How many brought in materials without being asked? How many pupils repeated science activities at home? Did pupils talk about their science experiences outside school?

Specific achievements can be used as a measure of success. What experiments were carried out? What field trips were taken? What projects were completed? What books were read?

One may look for signs of pupil growth. How many normally quiet children took active parts in class work? How many passive children took on leadership responsibilities? How many "slow" readers turned to books for information? How many pupils turned out work of improved calibre?

To measure the progress of individuals look for interest, effort, growth, and achievement. Not all children can be judged by the same standards, but if in his own way a pupil has shown evidence of each of the above, one may feel satisfaction with the results.

SPECIAL TECHNIQUES FOR TEACHING SCIENCE

Most of the teaching techniques used in other subject-matter fields apply equally well to science teaching. But when pupils begin to experiment, to perform demonstrations, to take field trips, and to build models, it is obvious that a teacher must have a knowledge of some additional teaching techniques.

The majority of the activities suggested in the Exploring Science Series are direct experience activities. They are simple and they are clearly described in the textbooks. A teacher should have little difficulty in helping pupils to carry them out, but if difficulties do arise, the detailed assistance given in the Teachers' Editions should quickly clear them up. The real problem that faces a teacher is not that of giving technical assistance with activities: the problem is finding ways to help pupils to gain the most from the experiences.

Science education stresses a number of major goals such as the development of critical thinking and the habit of withholding judgment. The activities which pupils carry out set up the situations that permit these goals to be attained. It is in working toward these major outcomes that many elementary teachers need help.

The Problem-Solving Approach

What a child learns may be of less value to him than the way he learns it. A curious child can be led to speculate, to experiment, to check conclusions. He can be given practice in defining problems.

He can be given opportunities to exercise his ingenuity. He can be encouraged to develop a critical attitude and an open mind. Such experiences are worth more to him than the bits of information he may pick up.

Elementary science is well-adapted to the problem-solving approach. The materials of science awaken curiosity: "How did this dandelion get in my garden?" "How can I connect this dry cell to an electric bell?" "Why does my dog prick up his ears when he wants to hear better?"

It must be remembered, however, that questions do not automatically become problems. A teacher may ask, "How do the people of Canada get their drinking water?" only to discover that few children care. Children are more interested in small and immediate problems: "How can fish stay under water?" Teachers should always re-examine the problems they intend to use to be sure that they have problems which challenge the pupils.

Answering Questions

It is a matter of courtesy to recognize all questions that pupils raise, whether the questions seem relevant or irrelevant, intelligent or silly. Perhaps if we could know all that goes on in a child's mind we would consider all his questions more seriously.

Recognition of a question does not mean that the question must have an immediate answer. Teachers probably answer too many questions for the good of the child. When a teacher answers a question, or selects one of the pupils' guesses as correct, there is nothing more for the pupil to do. It is better to encourage him to speculate, experiment, observe closely, and turn to recognized authorities for information to answer his own questions.

The more a teacher knows of a subject the easier it is to avoid the direct answer in favour of suggestions for finding answers independently. But when a teacher's background in a field is limited, it is still possible to make suggestions that send a pupil to experiments and to books for information—and for the answers.

A teacher must often say, "I don't know, but . . ." and follow up with suggestions for planning an experiment, or with the name of a recognized authority. There are innumerable questions that neither the teacher nor anyone else can answer. Physicists do not know why a magnet picks up iron. Biologists do not know why a bobolink migrates to South America in autumn. No one knows why the earth pulls things toward it or how a green plant produces sugar. The teacher must never be afraid to say, "I don't know." These are the words that challenge mankind. Perhaps that teacher's pupils will be the very ones to solve these age-old questions.

Experiments

Children love to experiment—to find out by "doing," as compared with learning through reading and being told. This is because children like to manipulate, they like to see things happen, there is an element of suspense involved, and perhaps they subconsciously recognize the validity of information gained this way.

Experiments in the elementary school should be informal. Problems are best stated in the words of the children. There is no place for the formalized pattern of "objective, apparatus, procedure, observations, and conclusions."

The best problems for experiments are the small problems that can be solved with simple equipment and in a short time. "Can a magnet attract a paper clip through cloth?" "Will grass turn yellow when a board is laid on it?" "Will cocoa pass through a filter?"

A number of worth-while problems arise from discussions that pupils hear at home. "Does hot water freeze faster than cold?" "Will aspirin tablets keep cut flowers from wilting?" "Is the coldest place in a room near the floor?"

Certain problems are too broad for children to solve. "Do plants need light in order to live?" "Does a fire need air in order to burn?" It would be improper to let pupils feel that they had answered such questions after two or three experiments. Instead of such problems, pupils should be encouraged to work on more limited problems. "Do bean seeds need light in order to start growing?" "Will a candle burn longer in a quart jar than in a pint jar?"

While pupils are carrying out an experiment, the teacher should refrain from influencing their conclusions. Only after the pupils begin to discuss their results should the teacher begin to raise questions that will encourage them to modify their conclusions. Perhaps the pupils have discovered that a pot of corn seedlings in a dark closet died after six days. Some of the pupils have decided that corn seedlings need light in order to live. The teacher may now suggest that the seedlings might have died anyway, perhaps because the soil was poor. She may then encourage the pupils to set up the experiment with another pot of seedlings in a light place.

Teachers are sometimes upset because an experiment does not "work." Actually, all experiments "work" in that they show that something happens or fails to happen. When an experiment does not turn out as anticipated, it is because some unconsidered factor has entered or because the expected result is wrong. But that is the fun of experimenting, not knowing what the results are going to be and trying to account for what does happen.

Field Work

The Exploring Science Series encourages field work as one of the most effective methods of learning science. Few are the units that do not suggest directly or indirectly some type of field work.

Possibilities for field work are almost endless. School buildings often have heating systems, gymnasiums, shops, kitchens, medical centres, and fire protection devices. School yards frequently have play equipment, flagpoles, shaded and unshaded areas, and varying kinds of vegetation.

Near schools there are often parks, gardens, vacant lots, and fields where plants can be studied. Where there are plants there are insects and other animals. Near schools there are sometimes automobile service stations, stores, greenhouses, and other business establishments. These present many opportunities for the study of science.

Field work should be planned carefully. Children should know what they are to look for. Do crocus blooms stay closed on cloudy mornings? How is air put in a tire? These are simple, direct problems well fitted for field investigations.

Outdoor experiments make good subjects for field work. The pupils may compare the temperatures of pans of water in sunshine and in shade. They may study the effect of sprinkling water on a pile of soil.

Field work is usually more effective when each pupil has something to do with his hands. The children may collect coloured leaves. They may take the temperatures of the soil in different places. They may write the answers to questions formulated before the trip.

Techniques for handling pupils in the field are somewhat different from handling pupils in the classroom. Each pupil must have something to do and he must know exactly how to do it. One of the important differences between indoor and outdoor situations concerns the amount of talking by the teacher. Lecturing and class discussion usually fail in the field because there are so many distracting elements. These techniques should be reserved for the preparatory and follow-up lessons. Once in the field, the teacher should generally talk only with individual pupils who come up with special questions.

Science Projects

Science projects exist in such rich variety that it is possible to appeal to the many interests and talents in a class. Children who like to work with tools enjoy making models. Children who like to draw and paint enjoy making posters, charts, and friezes. Children who like to write find opportunities to write stories and plays. Children who like to collect will enjoy preparing exhibits of their science collections.

Science projects such as these encourage pupils to plan, to use ingenuity, to persist at a job until it is done. Group projects give children opportunities to work together, to share, to assume leadership. The final products are tangible evidence of accomplishment and give the children deep satisfaction.

Such projects are important in the learning process. They bring together information and organize it in easily understood patterns. Often the projects give rise to new problems for the pupils to work on.

Completed projects should be put on exhibition whenever possible. Projects may be displayed in the foyer of the school, at Parents' Nights, and at P.T.A. meetings. They may be exhibited in store windows during Education Week. Local newspapers are usually delighted to publish photographs of exhibits and the children who made them; the teacher need only call up the editor and notify him of the displays. Through projects of this kind, parents gain a better understanding of what goes on in the school programme and children enjoy sharing their science experiences with them.

CONSERVATION EDUCATION

Elementary science should make significant contributions to conservation education. Science deals with plants and animals, rocks, soil and water, and with the scientific principles that control these natural features. Science helps to meet the three general objectives of conservation education—1) to give information about natural resources, 2) to develop desirable attitudes towards the use of natural resources, and 3) to give experiences with conservation practices.

Studies of the life histories of living things give an understanding of their problems. Each book of the Exploring Science Series includes a number of life history studies, and others are suggested in the Teachers' Editions.

Interrelationships among plants, animals, and their natural environments are also important. Better understanding of interrelationships would have prevented the admission of many animal and plant pests into this country, the extinction or near extinction of many species, and the many other mistakes we have made in handling our environment. This Series stresses interrelationships in all units dealing with the natural environment.

In general, when pupils gain sufficient backgrounds of information they develop proper attitudes. Having seen a badly eroded pasture, having learned the value of topsoil and the difficulty of replacing it, they recognize the waste and the need for conservation practice. They need no indoctrination; they draw their own conclusions from the facts.

These books also show children how to practise conservation for themselves. They are encouraged to take care of their clothing and their toys. They learn to conserve heat by closing doors and windows in cold weather. They are instructed in the prevention of grass fires and forest fires. They learn how to co-operate in fire prevention about the home.

Children are also encouraged to help to keep streets, roadsides, parks, and picnic grounds free from litter. Much education is needed in the proper use of one of our great resources, the beauty of the countryside. By taking pupils to places that are beautiful and then for contrast to places that have been abused, the teacher gives them training in an important area of conservation education.

HEALTH AND SAFETY EDUCATION

All areas of the elementary school curriculum must share in the responsibility for helping children to learn to take care of themselves. Science is especially important since it contributes much of the informational background necessary. By broadening its goals, the teacher may use science as the basis for the health and safety programme when classroom time does not allow for two separate programmes.

These are the areas commonly included in health and safety programmes for the elementary school:

The meaning of health
Body growth and development
Nutrition
Circulation and respiration
Digestion
Elimination
Bones (including teeth) and muscles
Skin, hair, and nails
The senses
Ears, nose, and throat
Rest and relaxation
Mental health
Sanitation

Communicable diseases and their prevention
Tobacco, alcohol, and drugs
Preventing falls
Safety with tools
Preventing fires
Traffic safety
Treatment of small wounds
Prevention of sunburn
Water safety
Safety with animals
Safety with electricity (including lightning)

The Exploring Science Series provides a combined science and health programme when such a combination is desired. Most of the units in each book contain health and safety material. For instance, the fourth-grade unit "Static Electricity" includes a lesson on safety during a thunderstorm. The sixth-grade unit "Water in the Ground" includes several lessons on safe drinking water. In addition, each book contains one or more units dealing primarily with health and safety, which are noted at the end of each book under "The Major Topics Presented in Each Unit." Thus a complete integration of the two programmes can be carried out in a completely natural way.

The flexible organization of the books permits the emphasis to vary according to need. If the school provides a separate health and safety programme, only a minimum amount of time need be spent on repetitious material in this Series. But if the combined programme is in operation, the health and safety material may be expanded as desired. The special helps in the Teachers' Editions show how to make the most of situations that arise from working with the Exploring Science Series.

It should be remembered that the science programme cannot assume the complete responsibility for health and safety education. Health and safety instruction must go on at all times. Children need orientation in the use of drinking fountains, public toilets, and school washrooms. They must be reminded constantly about washing after playing with things that dirty their hands, after going to the toilet, and before eating. They must be encouraged to play actively and then rest quietly. Safety in the classroom and on the playground must be stressed constantly. And the whole problem of mental health—good social adjustment, self-confidence, self-reliance—should be an every-minute-of-the-day concern of the teacher.

Detailed Teaching Suggestions for Book Two

Small children have much more aptitude for science than is often suspected. They can deal profitably with a wide range of topics, both biological and physical. Their thinking is surprisingly mature, and there is no excuse for "talking down" to them.

One must realize, however, that their background of science experiences is limited and that they are not prepared to carry on extended discussions or to interpret much of what is told or read to them. Science for small children should consist chiefly of direct learning situations.

It is well to set up as a primary aim for beginning science the development of a sound experience background. Discussions, reading, and telling should be limited and should be used to follow up information gained at first-hand. This means that beginning science should be taught in an activity programme in which there is ample freedom to experiment, to construct, and to follow up special interests.

It will be found that small children like to repeat their science experiences again and again. This is part of the learning process. Usually the children are working with science materials for the first time and they need the additional contacts for effective learning. It will be found that it is more efficient to let pupils use additional time for repetition than to push them hurriedly through a large mass of material.

Young children are not always ready to talk about their experiences immediately afterwards. They seem to need time to organize the information that they have acquired. It is better to wait until they are ready to talk than to force them into discussions. Talk and generalizations are less important at this level of science than is the experience background that is being developed.

Although verbalization in beginning science is of secondary importance, it will be found that many children pick up unusual scientific terms with surprising ease. It is not unusual to hear second-grade boys and girls talking fluently about "grasshopper nymphs" and "electric circuits." If there is no pressure, the children will add such words to their vocabularies when they are ready, that is, when they have had the proper experiences to give meaning to the words. In the specific suggestions that follow this section, there are mentioned a number of scientific terms suitable for children together with advice for introducing the words.

Exploring Science Two uses relatively few scientific terms. Second-grade children are not yet facile readers, and their books should use mostly those words with which they are familiar. Later books will add to the children's reading vocabularies the words that the children are just becoming acquainted with at this level.

In order that the pupils may use these texts as learning guides without being handicapped by the mechanics of reading, the reading level is kept below that of the second-grade readers with which it is to be associated. The first unit is of primer difficulty and the remainder advances to upper first-grade level. The vocabulary has been checked against standard word lists. The statements are simple and direct. Those sentences which are longer than one line are broken according to the natural divisions between phrases. There are only three pages (64, 71, 94) on which the page design necessitated breaking into the phrases. On all but eight pages (122, 123, 151, 160, 164, 166, 170, 171) each sentence begins on a new line.

The 440 new words introduced in *Exploring Science Two* are listed below in order of their first occurrence. Words and variants maintained from *Exploring Science One* are not listed. The 58 starred words comprise the special science vocabulary developed in *Exploring Science Two.*

WORD LIST

6 let's
*grasshopper
legs

7 large
eyes
small
parts

8 cage

9 sometimes
harm

10 lay
fall
ground
stay
all
winter
*hatch

11 come
green
and

13 bigger
but
*skin
under
breaks
open
crawls
old

14 both

16 far
jump
high

17 *crickets
like
sounds
with
*wings

18 more
*insects
move
where

20 *sun
did
see
*sky
was
today
noon

21 across

22 *east
*west
down

23 marks
show
home

24 made
by
seem
end
several
during

25 draw
again
same

26 *clouds
guess
why
next
picture

27 no
think

28 ever
seen
shapes

29 may
when
rain
always
if

30 night
*moon
saw
another
as

31 else

32 nearest
*earth
farthest
change

34 *thermometer
warm
cold

35 glass
*temperature

36 indoors
*aquarium
faucet

37 ice
boy's
pocket
warmest
found
coldest

38 play
bulletin
board
hold
sheet
red
paper
behind

39 each
read
real

40 lift
stone

41 *sunshine
*shade

42 fill
ink
clay
around
straw
push
be
sure
tight

44 keeping
record
outside
window
higher

45 blackboard

46 use

47 cook

48 car
ask
father
work
usual
classroom
lower

50 let
ball
pull

51 throw

52 downhill
straight
roll
faster

53 book
raise
slide

54 using
truck
farm
city

55 girl
she

56 hurt
us
would
better
him

57 list

58 than
pick
pail
sawdust
easier
try

59 measuring
measure
much

60 hang
string

62 machines
strongly
hard
often
heavy

63 name

66 *breathing
John
Sally
running
breathe
run
resting

67 through
*nose
*mouth
soda

68 *heart
felt
went
thump
beating
ran

69 his
*chest
doctor
listened

70 *experiment
brought
empty
he
over
Henry's
ear
against
heard

71 fast
could
few
minutes
fastest
slowest

72 *blood
tubes
pumps
body

73 neck
carry
head
fingers
feel
arm

74 fell
came

75 mother
cleaned
covered
well
get
dirty

76 sleep
should
very
take
care
best

78 *mirrors
*sunlight
spot
wall
*reflects

79 place

80 turn
explain

81 pan
piece
shiny
metal

82 fun

84 candles

85 three

86 together
doll
front

87 box
middle

88 automobile
dentist

89 barber

90 sign
letters
back

92 *electric
lamp
first
wire

93 bend

94 *binding posts
*dry cell
connect

95 touch
screws

96 ringing
bell

98 house

100 *electricity
strong
careful

102 *flashlight

104 *buds
schoolroom
*twigs
trees

105 cherry
soon

107 *scales
off
begin

109 needles

110 apple

111 summer
ripe

112 fruits

114 snow
lies
deep

115 *deer
*rabbits
alive
*bark

116 potatoes
called
stems
usually
sooner

118 Tom's
knife
had
got
birthday
sharp
lost

120 *rust
jar

121 been
wet
short
long

122 taking
tools

123 farmer
last
longer

124 pennies
dimes

125 *magnet
*iron

126 *oil
rub

127 man
shining

128 men
painting
bridge
kept

130 moving
wood

131 *rollers
fastened
along

132 round
pencils

133 chalk
spools

134 wagon
underneath
*wheel
rubber band

135 easily

137 floor
farther
useful

138 making
roller skate
*ball bearing
bicycles

139 lids
must
smaller
smallest
marbles

140 blue

141 stand

142 drop

143 wearing

146 *robins
family
*roots
mud

147 colour
might
near

148 sits
about
ten

149 *feathers
themselves
fly
feed

150 ducks
her
four
weeks

151 walk
tries
swim
hide
danger

152 hen's
boil
until
half

153 different
*white
*yolk
chicken

156 *branches

157 tall
digs

160 close
quickly
face

161 fan
yourself
engine
cool

162 *pinwheel
above

163 line
corners
dots

165 *windmill
before

166 say
clothes
dip
cloth
dries

167 size
hot

168 *wind vane

169 tie
stick

170 *weather
windy
hay
corn
pile
roads

171 *airplane
*pilots
who

172 carries
carried

Grasshoppers

PURPOSE OF THE UNIT

In the first grade the children studied the butterfly, an insect which passes through four distinct and sharply contrasting stages—egg, larva or caterpillar, pupa, and adult. Now, in the second grade, the children will study the grasshopper, an insect which represents a second general type of insect development, one in which there is a gradual change from the newly hatched nymph to the adult. In the words of children, "baby butterflies do not look like butterflies, baby grasshoppers look like little grasshoppers."

The distinction between the two types of life cycles should not be made at this time; reserve the distinction until pupils have a broader acquaintance with insects. But as other insects are encountered they may be compared to the butterflies or the grasshoppers in terms of the life cycle.

The grasshopper is important in its own right as a subject for study. It is common everywhere and it is easily recognized. It plays an important role in the lives of many other living things. And it often comes into conflict with man's interests.

One of the goals of science education is the development of the habit of making decisions on the basis of evidence rather than emotions. In this unit we have balanced the study of the damage done by grasshoppers with the part grasshoppers play in the diet of other animals. This helps to neutralize emotional prejudices which children are all too ready to develop. Children should not look upon animals either as friends or enemies; they should realize that animals can be helpful or harmful to our interests, or a little of both, or neither. Then they can make decisions on the basis of what they know. They may even decide to kill, but they will do it dispassionately.

It is important that we discourage the reading of stories in which grasshoppers think, act, or talk like human beings. Such stories lead children to assign human characteristics to these insects. There is no reason to believe that grasshoppers think as we do; there is no reason to assign to them such characteristics as laziness, cruelty, or maliciousness.

PREPARING FOR THE UNIT

This is an early autumn unit to be studied before frosts deplete the grasshopper population. In areas where frosts come early it is recommended that this be the first unit in the second-grade science programme.

There should be no shortage of material with which to work. A short walk through a vacant lot or an old meadow, or along a grassy roadside, stirs up dozens of these insects. One may catch them most easily with an insect net, and a little less easily with a kitchen strainer.

From an educational standpoint, the best way to collect grasshoppers is to take the entire class along and let the children do it. The children gain the best understanding of an organism by seeing it in its natural environment. A grasshopper brought into the classroom is in an artificial situation.

If a field trip is impossible, the next best thing is to enlist some of the pupils after school some bright autumn afternoon. Take along some screw-capped jars; the children will do the rest. The city teacher, who has only hot pavements to work with, may have to collect the material on a Sunday's drive into the country.

Hand lenses are useful for studying the grasshoppers. At least one lens for each pair of children is best.

The grasshoppers may be put in small screw-capped jars for study. A larger cage for extended observation is shown on page 8 of the text.

After the unit is started, children often bring in other species of insects. These can be put in glass jars for observation and then released after a few hours. A teacher should keep on hand a good assortment of glass jars for this purpose. Keep the insects cool. Put in some leaves or grass to raise the humidity. Punch holes in the jar caps to admit air.

List of Materials

Screw-top glass jars
Insect nets or kitchen strainers
Hand lenses
Flower pot

Yardstick
Coffee can
Wire screening

TEACHING THE UNIT

If at all possible try to open the unit with a field trip to catch some grasshoppers. It is surprising how often one may find material for good field trips within a couple of minutes' walk from the schoolhouse door.

Pages 4–5

These pages can be used to set the stage for the unit. **What are the animals in the grass? Who has seen them? Where? How can these insects go from place to place? Who has seen them jump? What do they use for jumping? Has anyone seen them walk? Who has seen them fly? How many wings do they have?**

This is a good time to suggest a trip to catch grasshoppers. Talk over what is needed, where and how to go. Give each pair of children a screw-capped jar and if possible a kitchen strainer.

Some of the children may be afraid to pick up the insects. Work calmly with them, trying to overcome their fears.

Other children will catch many more grasshoppers than are needed. Before returning to school, limit the pupils to one grasshopper per pair of children.

The grasshoppers may be kept overnight in the jars if a little grass is put in to provide moisture and if the jars are kept cool. Heat and dryness make the insects most uncomfortable and may kill them.

Pages 6–7

These pages will help the pupils to study the external appearance of the grasshopper. The grasshoppers may be kept in screw-capped jars and viewed with hand lenses.

How many legs has a grasshopper? Are all the legs the same? Which ones are much different than the others? Which ones are probably the strongest? With which one does the grasshopper jump? Look for the wings. From the pictures on pages 4 and 5 determine how many wings there are.

Arrange the children in a circle on the floor. Release a single grasshopper in the centre of the circle. Touch him to make him jump. Notice how the strong hind legs are used in jumping. Some kinds may also fly.

The grasshopper's face is interesting because it represents a type so different from our own. **How many eyes does a grasshopper have? How is the mouth different from ours? What does a grasshopper have on its face that we do not have? What do we have on our faces that a grasshopper does not have?**

From the actual specimens and from the pictures, the children will discover the two large eyes and the three small ones. The large eyes are compound eyes, made up of many small prisms. The small eyes are simple eyes. We do not know how a grasshopper uses these different eyes or what it sees with them, but the children will quickly discover that a grasshopper sees people in motion very well.

The children may be able to see that a grasshopper's jaws are arranged differently than ours—that the jaws work sidewards instead of up and down. They will also note the sense organs labelled "tasters" in the diagram; these organs may not detect taste as we know it, but the insects do seem to use them in selecting food.

The "feelers," technically called "antennae," are also sense organs we know little about. They are certainly sensitive to touch, but some authorities suggest they might also be used for picking up odours or tastes, or even high-frequency vibrations.

A grasshopper does not have a nose; it takes in air through pores along the sides of its abdomen.

Questions will probably arise about how a grasshopper hears and smells. Explain that there is much that is not known about the senses of insects. Grasshoppers can certainly see, but we do not know what things look like to them. They are also sensitive to vibrations of things they are resting on, but we are not sure that they hear. There are sense organs on the thorax of a grasshopper, as indicated by the nerves leading from these organs. But although it has been suggested that these are hearing organs, there has been no proof. The same is true of the "tasters," which may be used for smelling and tasting.

Page 8

Page 8 suggests one way of keeping grasshoppers for several days. By studying both the pictures and the actual insects find out how grasshoppers eat. **How is their method unlike ours?** Perhaps the children can see the sidewards motion of the jaws.

If desired, one may make a larger cage at this time to keep some of the grasshoppers into the winter. A framework of wood covered with screening is satisfactory. Put some sod in the cage and keep it moist. Put in a few grasshoppers. Release the rest of the grasshoppers. The grasshoppers in the cage may eat, mate, and lay eggs. If some of the immature forms are put in they may develop into adults.

Page 9

This page touches upon the damage grasshoppers sometimes do. In some regions the damage may be severe enough so the pupils have experiences to relate. Sometimes it is possible to take the class to see some of the damage. It may also be possible to bring in and exhibit plants that have been stripped of their leaves by grasshoppers. But if grasshoppers are not pests in a particular locality, there is little advantage in dwelling upon this aspect of their lives.

Pages 10–11–12–13

Egg laying is illustrated on page 10. The term "female" may be introduced, but do not expect the children to use the term freely at this time.

When do grasshoppers lay eggs? When do the eggs hatch? Where are the eggs all winter? These questions may be answered from the text.

In large cages under favourable conditions female grasshoppers will often lay eggs. If the cage is then put in a cool place until spring, the eggs may hatch.

The next two pages deal with the development of a grasshopper. After giving the children time to study the pictures, ask questions such as the following: **Do grasshoppers change as they become older? How long does it take for a grasshopper to become fully grown? When do the wings appear?**

Page 13 tells how a grasshopper grows. It is a manner so unlike ours that it is both interesting and profitable to study it as a manner for all insects. Let the pupils read the page first, then ask questions. **What part of a grasshopper does not grow? If the skin cannot grow how can the grasshopper grow? How does the grasshopper get out of the old skin? What happens to the old skin? How is the new skin different from the old skin?**

Explain to the children that the new skin is soft and crumpled up inside the old skin. Shortly after shedding, the new skin swells and hardens into its bigger shape.

Pages 14–15

Grasshoppers play an important role in the biological world by making up a large share of the summer diet of many animals. The children know the crow and the fox. How many of those on page 15 do they know? Those shown are 1) the sparrow hawk, which might better be called the grasshopper hawk; 2) the garter snake, representing many smaller insect-eating snakes; 3) the grasshopper mouse of the midwest, or the deer mouse, representing the many mice that eat insects; 4) the skunk, which makes insects a large part of its diet in late summer; 5) the toad, which eats many small grasshoppers. Besides these animals there are many others, such as bobolinks, which feed on grasshoppers.

Page 16

The children will be interested in seeing how far a grasshopper can jump. Several grasshoppers can be tested and the results recorded on the blackboard.

Pages 17–18

It is not intended that pupils recognize the relationships between grasshoppers and others of the order, like the katydid and praying mantis shown here. Rather the children can note some of the obvious similarities—the number of legs, the wings, the powerful hind legs. They may be told that the way of growing up is about the same.

Crickets are easy to keep and study. The cage shown on page 8 can be used; it is usually better to keep each type of insect alone. The crickets can be fed on bits of bread and apple. Males will often chirp; this always delights the children and they may be able to see the process.

Summary Questions

1. The children have probably seen the grasshoppers walk and jump. They may have seen grasshoppers fly; if not, the pictures on pages 4 and 5 give them this information. The insects use all six legs while walking; they use the hind pair for jumping. The adults use the four wings for flying.
2. In common with most adult insects, grasshoppers have six legs.
3. The picture on page 7 shows two large eyes and three small eyes.
4. The children may answer this question with the words "grass" or "plants." Encourage them to be more specific by giving the names of the plants they have seen grasshoppers eat. Ask them if they know whether grasshoppers eat all kinds of plants.
5. The children may answer with the names of the animals shown on pages 14–15. Perhaps they have learned that other animals also eat grasshoppers and will respond with the names of some of these. Most fowls and the song birds that feed on the ground eat small grasshoppers. Larger fowls and gulls feed on large grasshoppers as well.

Field mice, raccoons, and even bears also feed upon grasshoppers.

6. Page 10 tells how the female grasshopper lays her eggs in a hole in the ground. Encourage the children to describe the process as shown, together with any other observations they may have made.

7. Two types of answers may be given. One may deal with the increase in size and the shedding of the skin. The other answer may deal with the stages through which the grasshopper goes from egg to adult as shown on page 12. Both answers are desirable.

8. The pupils may refer back to page 9 or to their own observations in order to describe how grasshoppers can damage garden plants by eating their leaves.

Follow-up

If grasshoppers are kept in a large cage the children should be encouraged to keep watch of the activities of the insects. They may draw pictures and write stories of their observations.

Independent field work can be encouraged. Pupils may tell what they have seen outside school, and they may bring in specimens.

After several heavy frosts, a trip to note the scarcity of grasshoppers points out the relationship between these insects and the weather.

In late spring the pupils may be asked to look for young grasshoppers that have recently emerged from the eggs.

POSSIBLE LEARNINGS

Grasshoppers are insects.
Grasshoppers feed on many plants.
Many animals eat grasshoppers.
Grasshopper eggs are laid in the ground in the fall.
Young grasshoppers hatch in the spring.
Grasshoppers grow by shedding their skins.

BIBLIOGRAPHY

Books

First Book of Bugs. Margaret Williamson. Ambassador Books: Toronto, 1949. 44 pages.

Tells the food, habitat, enemies, and much more of many insects.

Grasshopper Book. Wilfrid Bronson. W. J. Gage: Toronto, 1943. 127 pages.

An illustrated book valuable for the teacher.

Films

Insect Zoo. Encyclopaedia Britannica Films. Ontario Department of Education: SN-96.

Ted's and Susan's zoo includes katydids, crickets, beetles, ants, and a praying mantis.

SN-137 The Grasshopper: A Typical Insect. Ontario Department of Education.

The body structure of the grasshopper is shown as exemplifying the basic characteristics that identify insects.

Watching the Sky

PURPOSE OF THE UNIT

This is an observational unit extending the pupil's information about, and appreciation of, that part of our surroundings we call the sky. It is important that children be encouraged to notice things around them at an early age. Once something interesting has been pointed out to a child he will begin to make related observations independently. Then the guided experiences plus the independent observations give meaning to new experiences that he may have. There is an interaction between in-school and out-of-school experiences that results in ever-widening horizons. The sooner this process starts, the better.

The material in this unit cuts across several of the large areas of science—areas such as light, air, weather and astronomy, the latter containing such subdivisions as directions, time, change of seasons, and motions of the earth.

In the area of astronomy, as in every other area of science for the early grades, it is essential that we deal with things that the children can observe. In this unit, emphasis is placed upon the daily motion of the sun across the sky.

A teacher should not be disturbed because the children state that the sun moves. The children are correct. Motion is always relative to the observer; to us on the earth the sun is in motion. If we could go to the sun, the earth would be in motion. If we could stand far out in space we would find that both the sun and the earth are in motion.

Obviously, small children are not ready to project themselves in imagination to such distant points. When they grow older and have a wider background of observation on which to build we shall introduce carefully the generally held theory about the motions of the earth and the sun.

Two important subdivisions of astronomy are introduced—time and direction. The regularity of the sun's motion is an unavoidable observation. The use of the sun in finding directions is also a logical extension of the observations of the sun. At this time only east and west directions are introduced, but many pupils will grasp the north and south directions with a little help.

The study of clouds in the sky is elementary, little more than was done in *Exploring Science One.* Pupils are asked to note the presence or absence of clouds, to note the relationship between clouds and rain, and to consider the effect of clouds on the visibility of the sun, moon, and stars.

PREPARING FOR THE UNIT

No apparatus is needed for the teaching of this unit except simple materials which can be picked up as needed.

The unit can be taught at any time of the year, with the resourceful teacher taking advantage of any interesting and unusual sky conditions. In the sequence of units, "Watching the Sky" has been located in early fall so that outdoor observations can be made comfortably and so that a larger part of the school year can be used for follow-up activities.

List of Materials

Pole for shadow stick
Wood pegs
Hammer
Large sheets of wrapping paper

TEACHING THE UNIT

Page 19

The unit may begin with a study of this picture. **What things are shown in the sky? What other things might we see in the sky in the daytime? What might we see at night? Notice the shadows of the cloud and the airplane. Which must be nearer the earth, the sun or the cloud? The sun or the airplane?**

On a favourable day look out of the windows for cloud shadows. See if the children can locate the cloud that casts one of the shadows.

Ask the children to make pictures of the sky as they see it at different times of day and in different kinds of weather. Prepare an exhibit of these pictures.

Pages 20–21

A beginning toward an understanding of the sun's motion across the sky was made in the first-grade unit, "Watching the Flag." However, one should not assume that all pupils have grasped the concept. Build toward it very carefully.

Take the children outdoors to notice the position of the sun and its shadows in the morning, and again in the afternoon. Take them through the school building to find rooms that are sunny in the morning and to find rooms that are sunny in the afternoon. Have them keep track of the different positions of a sunbeam in some south-facing room. Encourage them to make independent observations out of school.

When a large number of observations have been made, ask them to point out the path of the sun across the sky. Repeat this on succeeding days until all pupils seem to have grasped the concept.

Pages 22–23

After the concept of the sun's motion has been thoroughly established, one may introduce the east-west concept. This is done by letting them read page 22 which tells them that the sun appears to rise in the east and set in the west.

Take the class outdoors in early morning. **Where is the sun? Which way is east? Which way is west? Point east. Point west. Which way do shadows point in early morning?**

The teacher should assist the children in drawing an east-west arrow on the sidewalk or on the ground.

Take the children outdoors in the afternoon and ask them to point to the east and to the west as before.

The concept of east and west can be established only after many experiences. On succeeding days the children may review some of the experiences already suggested. They should discover which side of the building faces east and which side faces west. They should decide which classrooms are on the east and which rooms are on the west side. In their own classrooms they should recognize east and west; they may chalk directions on the floor and they may hang placards on the walls. They should be able to say whether prominent buildings and other landmarks are to the east or west of the school.

The pupils should be encouraged to locate directions at home. They should be told about any local streets that are divided into east and west sections.

Some pupils will also be ready to grasp the north-south concepts, but the teacher should not force them into the study of these directions.

Pages 24–25

Understanding of the changes in shadows as the sun moves into different positions in the sky has great significance in later studies of time, direction, and seasonal change. These pages give two of the many methods that can be used in pointing out some of the changes in shadows through the day.

Marking the end of a shadow shows the change in both its position and length as the sun's position changes. Besides using the shadow stick illustrated, the children may mark the ends of the shadows of a tree, a flagpole, and a roof top.

Indoors, the children may mark on the floor the positions of the shadow of a piece of heavy paper glued to a window-pane. They may mark the position of the sunlight falling through a window on the classroom floor.

After numerous observations of changing shadows and the movement of the sun across the sky, the children are ready for the concept of *noon.* They should be taken outdoors to note the position of the sun at noon or near noon. They should note that the shadows are shorter at noon than at any time of day. If they cannot read time, they should be shown how to recognize noon on a clock face. They may set an alarm clock for noon and use it as a signal to look at the shadows.

If the children drive a peg into the ground at the end of a shadow every hour, they may use the pegs and the shadows as a crude sundial.

The activity involving their own shadows fascinates children even as it points out vividly the change in shadows throughout the day. Long sheets of wrapping paper may be used for the shadow pictures. The children like to show these sketches to other people.

Pages 26–27

This is a repetition of an idea introduced in *Exploring Science One.* Many children do not realize that on cloudy days the sun is still above the clouds. Nor do they appreciate the relationship between the sun and daylight.

These pages review the effect of clouds on sunlight, pointing out that when we cannot see the sun in the daytime there is a cloud between the sun and ourselves. To this is added another idea—that the clouds are moved by the wind.

Follow the discussion with observations of the sky. On days with broken clouds, wait until the sun is covered by a cloud and point it out to the children. Ask them when they will see the sun again. Ask them to point to the sun. Have them make pictures showing the passage of the clouds across the sun.

On calm days or days when there is a gentle wind, ask them to note the speed of the clouds. On windy days ask them to note the speed of the clouds. It is best to use the low cumulus clouds for this study; high cirrus clouds are so far away their motion is difficult to detect.

Pages 28–29

These pages continue cloud study. Call the attention of the pupils to the clouds on different days. Do not try to identify clouds by name; there is no significance to the names at this level.

In some kinds of weather the sky is covered with a thin sheet of cloud through which the sun shines dimly. In such weather ask the children to point to the sun. See if they can guess why the sun is so dim. Encourage them to watch the sky to see if anything happens; usually the clouds gradually thicken and the sun becomes invisible.

On other days the sky may be covered with a thick layer of clouds and the sun may not be visible. Ask the children where they think the sun is. Ask them to try to point to it, using their experience on clear days as a guide.

The children may make paintings of the sky showing various kinds of clouds. They may also represent the clouds by using chalk on blue drawing paper.

The class may also start a record of sky conditions. On a large sheet of paper, preferably blue, mark off a blank calendar. Leave the space for a particular day blank if the sky is clear. Draw appropriate clouds with chalk to indicate the kinds of clouds seen on partly cloudy days. Chalk in the whole space for days when the sky is completely cloudy. Use a symbol such as an umbrella for rain. Occasionally have the children note whether it ever rains on clear days and whether there are clouds on rainy days.

Pages 30–31

These must be discussion pages, but the pupils can be encouraged to make observations of their own at home. Ask them to look for the moon, stars, and clouds at night. A record of the shape of the moon may be kept by cutting out the appropriate shape from yellow drawing paper. The moon is visible in the afternoon during the first half of the moon; it is visible in the morning during the last half of the moon. Point it out to the children when it can be seen during school hours.

Page 32

This page introduces an important and more advanced idea. Relative distances of things in the sky are not always easy to determine except when one object passes in front of another. But by continued observation the children will learn that the sun is farther away than other common things in the daytime sky. They will learn that airplanes and clouds are sometimes at about the same distance from the earth, and that clouds are at different heights.

Summary Questions

1. The children should answer with the names of such things as are referred to in this unit—sun, moon, stars, airplanes, clouds, birds—and they may add other things within their experience such as smoke, balloons, kites, and butterflies.
2. We see the sun only during the daytime and only when there are no heavy clouds in the sky. We do see it if there are thin clouds during the daytime.
3. We do not see the sun at night or when there are heavy clouds in the sky.
4. The sun appears to rise in the eastern part of the sky.
5. The sun appears to set in the western part of the sky.
6. The shadows change their positions and they change their length. The children should realize that the shadows are shortest at noon and longer in the afternoon and morning.
7. The clouds move because the wind blows them along.
8. Let the pupils describe, with the aid of diagrams, the shapes of the moon they have seen.

Follow-up

Sky study may continue throughout the school year. Children may keep weather records. They may be encouraged to watch for clouds. They should be given practice in using directions. They may note shadows of objects at various times. Whenever something new and interesting appears, the teacher can well afford to give the three or four minutes needed to call attention to it. Remember that it is neither necessary nor desirable to explain everything seen; pupils should understand that teachers, like everyone else, do not know everything.

POSSIBLE LEARNINGS

Of the things we see in the sky, the sun, moon, and stars are farthest away.

The sun rises in the east and sets in the west.
Shadows made by the sun point in different directions through the day.
Shadows made by the sun change in length through the day.
Clouds have different shapes and sizes.
Clouds are blown across the sky by the wind.
Clouds sometimes cover the sky completely.
The moon moves through the sky.
The moon has different shapes.

BIBLIOGRAPHY

Books

Follow the Sunset. Herman and Nina Schneider. Doubleday: Toronto, 1952. 43 pages.
A trip round the earth with the sun. Contains songs.

How Big Is Big? Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1946. 42 pages.
A simply-written, well-illustrated book about the biggest and smallest things of the universe.

Let's Find Out. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1946. 38 pages.
Air, heat, weather—a picture science book.

Sun Up. Alvin Tresselt. Ambassador Books: Toronto, 1949. 25 pages.
A story poem describing the hottest day of the year.

Films

North, South, East and West. Jam Handy.
Night and Day. Jam Handy.

The Thermometer

PURPOSE OF THE UNIT

One of the ways in which we can learn more about our surroundings is by measuring things. Second-grade children readily learn to measure temperature if we ask them to read only the marked divisions on the scale; these are usually given in tens of degrees. Some children will be able to read the fractional divisions, but the others should not be forced to do so.

This unit on the thermometer makes an appropriate starting-point for developing understandings regarding some of the quantitative aspects of science. In science we are interested not only in knowing the what and the why of things around us but we are also interested in knowing how much.

A variety of experiences centred around the thermometer will give a rich background for the studies concerning temperature and its relation to our everyday lives. These experiences will be utilized in succeeding units dealing with heat, weather, and similar subjects. The thermometer will be one of the common tools at all levels of the science programme.

It is important that the children understand what the thermometer really measures. A thermometer measures temperature; it tells how warm something is. There is a tendency to confuse heat and temperature. If the teacher will always speak of the thermometer as measuring temperature, later confusions will be avoided.

PREPARING FOR THE UNIT

This unit may be taught at any time of year, but it is particularly appropriate in the fall when temperatures are dropping. When we are expecting frost, or possibly the first snowfall, we seem to be more interested in temperature and more conscious of it than at any other time of the year.

A number of interesting activities are suggested in the unit. For these activities a few pieces of equipment which may not be part of the regular classroom supplies will be needed.

Chief among these items are several thermometers. One large thermometer is desirable because it is easier to teach the children to read the large scale. Several smaller, inexpensive ones, two at the minimum and more if they can be afforded, will be used by the children in their observations. When buying these thermometers locally be sure to buy those that read identically under the same conditions. An outdoor thermometer is valuable. For enrichment of the unit different kinds of thermometers such as cooking thermometers are useful.

The text suggests the use of soda straws and modelling clay for making a crude thermometer. Better than the soda straw is a piece of glass tubing, and better than the clay is a one-hole rubber stopper of the proper size. These can be borrowed from a general science teacher who will also show the safe method for inserting the tubing in the stopper. Because the straw and the clay are more familiar to the pupils, it might be wise to start with the straw and the clay and then introduce the glass tubing and the stoppers after the basic understanding of the thermometer has been established.

List of Materials

Household thermometers
Glass jars
Pans
Ice cubes
Sheet of white card
Sheet of red card
Scissors
Ink bottles
Soda straws or glass tubes
Modelling clay or one-hole rubber stoppers
Red ink
Different kinds of thermometers

TEACHING THE UNIT

Page 33

What is the teacher pointing to? What does a thermometer do? Is there another thermometer in the picture? Is there a thermometer in our classroom?

In the picture which thermometer has more red showing? What does this mean? Put a thermometer outside the window and put another inside to see if they change.

Do you have thermometers at home? Where are they located? Do you know of other places where there are thermometers?

Give all the children an opportunity to handle a thermometer and see it close up.

Pages 34–35

Carry out the activity suggested on page 34, either as a demonstration or better still as a small group activity, when there are several thermometers available. Be sure to check the range of the thermometers and do not use water that is too warm lest the thermometers be broken.

Then, beginning with page 35 and turning quickly to real thermometers, teach the children to read thermometers. Most thermometers are divided into units of ten degrees. Teach the children to say "almost 50 degrees" and "a little more than 90 degrees." Some children may be ready to read the smaller, unlabelled divisions but many of them will not be.

Pages 36–37

After the children have learned to read a thermometer and have acquired an appreciation of the variations in temperature, they will be interested in using the thermometer to find the temperatures of various things in the classroom. Four suggestions are given here but many other places can be tested. Let the pupils choose their own places and do not hurry them.

Encourage the pupils to record their observations and try to have pupils check each other. Encourage them to make observations on successive days to see if there are important changes in temperatures.

Check the temperatures of ice-water on different days. It is important that children learn at an early age not to accept single observations as final but to check them carefully again and again.

Pages 38–39

The activity described on these pages helps pupils to learn to read a thermometer and it also serves as a record-keeping device.

Ask the pupils to study the pictures carefully and decide upon the materials needed. Then help them to plan and carry out the project. Laying out the scale and putting on the figures may be the teacher's contribution. After the thermometer is made, the children may decorate it with pictures such as drawings of children dressed in clothes appropriate for different temperatures; these may be pasted opposite corresponding positions on the scale.

Perhaps the teacher would prefer to use some other type of model thermometer. There are many kinds, some of them using coloured ribbons to represent the liquid in the thermometer. However, the one described is simple for children to construct.

Pages 40–41

Try to make as many outdoor observations as possible, going out in different kinds of weather to get a better appreciation of the ranges of temperatures outdoors. Try to take the temperature of freezing water as many times as possible because this temperature is a critical one.

On a sunny day take temperature readings in both sunny and shady places. If two different thermometers are used be sure they agree with each other under the same conditions. One thermometer may be used by carrying it from one place to the other.

Ask several pupils to take similar readings and record them. Then compare results. There may be differences because the thermometers do not read the same or because of errors in reading. There may also be changes in conditions. Encourage the pupils to account for differences.

Pages 42–43

The problem may be raised as to how the thermometer works. These pages give an activity that makes a partial explanation.

The working part of a thermometer consists of a thin glass tube with a bulb at one end. The bulb is filled with a liquid that is usually coloured to make it easier to see.

Liquids generally expand when heated and grow smaller when cooled. When the thermometer tube is placed in a warm place the liquid in the bulb grows bigger and some of it is forced up the tube. Heating the liquid still more forces it farther up the tube. If the thermometer is cooled the liquid contracts and drops lower in the tube.

The scale is put on after the tube has been made. It is made to agree with some thermometer known to be accurate.

The demonstration thermometer described on these pages may be made by the pupils with the help of the teacher. Pour about a teaspoonful of red ink into an empty ink bottle and then pour in enough water to fill the bottle. The mixture should be a deep red colour. Now wrap the clay round the straw and force the wad of clay into the bottle. Some of the red liquid will rise in the straw.

As explained before, glass tubing permits more visibility and a rubber stopper fits more tightly. These may be used if desired, but the teacher should learn how to insert the tubing in the stopper and should not permit the children to do it lest they cut themselves.

Pages 44–45

Record keeping is a part of science training. The preparation and interpretation of simple tables of the type shown here are quite within the capacities of second-grade children.

It may be profitable to keep a temperature record for only a week or two; much depends upon the interests of the children. It may be more valuable to keep different kinds of records. A record of temperatures through the day may be useful in showing how air temperatures vary as the day advances.

Pages 46–47–48

These pages show some ways we use thermometers. The children may be able to suggest other ways. In each case, find out why it is important to know the temperature taken.

The children should be able to understand that mothers take the temperature of the baby's bath water so that they do not burn the baby and so they do not chill the baby. The fever thermometer may tell us when we are sick because our temperature often rises when we are sick. Cooking thermometers tell us when the temperature is right for baking or roasting, and when some mixture is hot enough as when making candy. The thermometer in an automobile tells us if the engine is becoming so hot it might be damaged.

If possible, show some different kinds of thermometers and explain how they are used.

Summary Questions

1. Simply stated, a thermometer is for telling the temperature of something, or for telling how hot it is. The pupils may give specific uses, anticipating question 5.

2. The simplest answer is that the liquid rises in the thermometer when the temperature increases, and that it goes down when the temperature decreases. However, some pupils may wish to explain the motion by saying that the liquid becomes bigger when the temperature increases and it becomes smaller when the temperature decreases.

3. Most schoolrooms are kept at a temperature slightly over 70 degrees. The purpose of the question is to see if the children can give a quantitative value to some common temperatures.

4. Ice-water is always at 32 degrees or "a little more than 30 degrees."

5. The methods given on pages 46, 47, and 48 may be given with any other methods from the children's own experience.

6. We really read the temperature of the thermometer when we read thermometers. A thermometer in sunlight reads higher than one in shade because the thermometer is warmer; the air may not be greatly different in temperature. But we are interested in sensations, and the children's answer that it is warmer in sunlight than in shade is satisfactory.

Follow-up

Keeping records represents one important form of follow-up activity. In addition, have the children note outdoor temperatures on very cold days and on very hot days. Sometimes call attention to the temperature just before the children leave for home so that they are thinking about it as they leave the school. If the classroom should be unusually cold some morning ask the children to read the temperature.

POSSIBLE LEARNINGS

Thermometers tell us how warm things are.
Temperature of the air outdoors is variable.
Temperature of the air indoors is more constant.
Things become warmer in sunlight than in shade.
Water tends to change in volume as the temperature changes.
Freezing water and melting ice have a constant temperature.

BIBLIOGRAPHY

Books

Let's Find Out. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1946. 38 pages.

Air, heat, weather—a picture science book.

Thermometers, Heat, and Cold. Bertha Parker. Copp Clark: Toronto, 1942. 36 pages.

The teacher will find this useful in teaching about thermometers and their uses.

The Pull of the Earth

PURPOSE OF THE UNIT

The pull between the earth and objects near it is one of the basic concepts of science. An understanding of it is necessary for interpreting many everyday phenomena. Unfortunately, explanations are usually made in terms of the word "gravity" without any attempt to give the word meaning. Then the word takes on a somewhat mystical connotation.

In *Exploring Science Two* the word "gravity" is not used, but the concept of the earth's pull is carefully developed. Thus objects fall because they are pulled down, just as they would move in any direction if they were pulled sufficiently. Likewise weight is a force instead of a physical property of something as so many people consider it.

The teacher should realize that we believe objects pull on the earth with as great a force as the earth pulls on them. Because the earth is so much greater, the effect of this pull on the earth is negligible. It is not mentioned in this book. And the teacher will inevitably be faced with the question as to why the earth pulls on things; to this there is but one answer, "I don't know." The cause of the pull, like magnetism and life itself, has no explanation that mankind understands.

In this unit some attention is given to the way we use the pull of the earth. Usually people take for granted some of these important uses. But one goal of science is to develop the habit of noticing and questioning instead of taking things for granted. A teacher should help pupils to develop this habit by making them aware of things about them.

Some bad effects of the pull of the earth are also noted, and the unit is given a slant toward the study of safety. A very high percentage of accidents are caused by falls, and we cannot do too much to help people to eliminate the causes. A teacher will do well to expand this section of the unit far beyond what could be done in this book.

PREPARING FOR THE UNIT

The only equipment called for by the unit, aside from some balls and some boards and a few other minor items, is a set of scales. The scales used to weigh children are well suited for the activities suggested. If the school does not own scales of this type, perhaps a set of bathroom scales can be borrowed.

The unit can be taught at any time of year. It has been included fairly early in this programme so that the situations that constantly arise through the year can be used to best advantage as a follow-up for this unit.

List of Materials

Balls
Boards
Things to roll down boards
Pails
Sawdust
Scales

String
A strong spring
Models of dump trucks, derricks, loaders and similar machines

TEACHING THE UNIT

Page 49

The first questions dealing with this page concern the activities of the children. Then questions can be asked concerning the methods by which the apples can be made to fall. Finally the question is raised, **Why do the apples fall? Why don't they stay up in the air?** This sets the major problem for the unit.

Pages 50–51

After the pupils have tried out the first simple activity and read the explanation in the book, give them an opportunity to try out and explain the falling of many things—balls, stones, chalk. Then let them add more things from their past experiences—rain, fruit, arrows, water from a hose. They should be able to build up an extensive list of things they have seen fall.

Pages 52–53

When things cannot drop straight down, the pull of the earth may make them roll or slide down slopes. The children should have a wealth of experiences from which to draw—riding down hill on wagons and sleds, letting sand slide off a shovel, watching snow or rain come off a sloping roof. Do not hurry the children through these pages. Give them ample opportunities to describe their own experiences and to recall things that are a bit vague in their minds.

Pages 54–55

Although the pupils may not have thought about it, we use the pull of the earth in a great many ways. The past experiences of the pupils will determine the nature of the discussion. Farm children will have noticed that hay falls into and from a mow, seeds are dropped into furrows, milk is poured from buckets into cans. City children may have noticed coal being delivered down a chute, cement being poured from mixers, mail being dropped into boxes. And at home, liquids are poured from bottles, ashes drop to the bottom of a fireplace or furnace, and bathtubs and showers are emptied by letting the water run from holes in the bottom.

Pages 56–57

These two pages show two common situations that result in accidents through falls. Lead the children in a discussion that analyses the situations for the danger spots. Ask them to suggest ways of decreasing the danger.

Consider with the pupils other situations that are dangerous because the earth pulls us. It might be well to take a typical home, room by room, listing such situations as standing in bathtubs, letting marbles roll around the floor, climbing on chairs to reach things. Then moving outdoors, consider such situations as ice on steps, wagons left where people may trip on them in the dark, and ladders that are not put up properly.

This is a very important section of the science programme; it should be amplified as much as possible in terms of local situations.

Pages 58–59

The activities shown here lead to a realization of the variation in the pull of the earth on different objects. They introduce properly the idea of weight being a force rather than a property of a substance.

Provide things of different weights for the children to lift, being careful of course that there is nothing so heavy that the pupils may hurt themselves trying to lift it. Teach them to lift heavier things correctly: keep the back straight and do the "lifting" with the legs. Fill some equal-size boxes or cans with different things such as nails or cotton. Then let the pupils decide which ones are pulled more by the earth.

As they experiment, encourage them to talk in terms of the pull of the earth.

Give the pupils extensive practice in weighing things. Spring balances are usually easier to use; perhaps a set of bathroom scales can be borrowed. The children may weigh all sorts of common things—books, chairs, themselves, jugs of water, cans of sand. These activities give them a chance to learn through their kinesthetic sense, their muscular sense, about the densities of things. They can never make the same discoveries from books or by watching others.

Pages 60–61

These activities are self-explanatory. In the first case the earth's pull on the pail increases until the string has not the strength to balance it. The pupils can test the breaking-point of string by this method. They may load the pail until the string snaps and then weigh the pail. They should not accept a single measurement but should make several trials. They may also test other thicknesses of string and thread.

The second activity involves a spring which stretches as the earth's pull increases. This is the principle upon which spring scales operate, and if one is available it may be studied. Besides the coiled spring shown, one may use rubber bands, including those cut from an inner tube.

Pages 62–63

These are discussion pages that allow the children to contribute from their past experiences. Page 62 shows a large crane; 63 shows a snow-loader. After the purpose of such machines has been established, try to arrange some trips to see one or more of them, preferably in action. There are also some toys that are working models of machines that lift things; perhaps some of these can be brought to school.

Page 64

Probably most of the pupils know that a heavy person will overbalance a light person on a seesaw. Now they may think of the effect in terms of forces—that the earth's pull on one side is greater than the earth's pull on the other. Take the children to a playground, find a seesaw that is nearly in balance and put different children on opposite ends. See which ones are pulled more by the earth.

Summary Questions

1. Things fall because the earth pulls them.
2. Things roll down a slope because the earth pulls them.
3. The pupils may give the uses of the earth's pull as described on pages 54–55 and some of the many other uses within their experience.
4. The earth's pull may hurt us by making us fall or by making things fall on us. Encourage the children to give specific examples.
5. We measure the earth's pull with scales.
6. We use derricks, loaders, shovels, pulleys, and many others. Children may not know the names of all the machines they are acquainted with, but they can describe what the machines do.

Follow-up

Whenever things fall, use the opportunity to speak of the pull of the earth to give greater practice in thinking in terms of forces. Likewise in speaking of weights, refer to the earth's pull.

Be on the alert for ways the earth's pull is used to our advantage and for machines that help us to lift things against the earth's pull. Concentrate on the safety angle at every opportunity.

POSSIBLE LEARNINGS

Things fall because the earth pulls them down.
Things roll or slide down a slope because the earth pulls them.
The earth's pull can harm us.
We use the earth's pull in a great many ways.
The earth may pull with a different force on different things.
We measure the earth's pull with scales.
We have machines that help us to lift things.

BIBLIOGRAPHY

Books

Gravity. Bertha Parker. Copp Clark: Toronto, 1942. 35 pages.
Information about gravity in simple language.

Who's Upside Down? Crockett Johnson. S. J. Reginald Saunders: Toronto, 1952. Unpaged.
An amusing introduction to the idea of gravity for very young readers.

When We Run and Play

PURPOSE OF THE UNIT

In this unit we extend the pupil's acquaintance with their bodies to include some elementary knowledge of circulation and respiration and some of the effects of exercise. Later this knowledge will be used in studying nutrition, respiration, circulation, and other important functions. The unit builds upon the *Exploring Science One* unit, "We Are Growing." The ultimate goal is a sound foundation for the teaching of wise health practices.

It should be noted throughout this series that the sequence in human anatomy and physiology deals with the normal, healthy human body. There is no reference in this unit, for instance, to heart diseases or abnormalities. Nor is there any morbid connecting of the heart-beat and death.

Children are usually interested in themselves and we should utilize this interest to give pupils important information about themselves. But if we allow them to be conditioned by morbid thoughts, they may refuse to learn about themselves or they may become worried about slight or suspected abnormalities.

Health and safety materials are included in the unit, as the stage is set for a discussion of safety in play, as the need for proper treatment of minor injuries is shown, and as opportunity is provided for considering the subject of rest. These are important topics for young children.

The observations and understandings developed in this unit call attention to and give meaning to unplanned experiences of the pupils, particularly in out-of-school situations. Thus is provided a desirable interaction between in-school and out-of-school experiences. Through this interaction we are encouraging independent habits of observation and thinking—the very basis for the scientific method.

PREPARING FOR THE UNIT

Some drinking glasses, soda straws, and empty tin cans are all the required materials for this unit, but there are many other materials that can be used for enrichment.

A stethoscope can be purchased from a science apparatus supply house; it repays its small cost in terms of pupil interest. A large, simplified chart of the human circulatory system is helpful; such charts can be borrowed from high school science and health teachers. Sometimes these charts are a little too complex; it is better then to copy off the basic details on a blackboard.

One may buy the heart of a cow, sheep or pig to cut open and show the blood chambers. However, use a fresh heart from a butcher's. Hearts preserved with chemicals and sold by scientific supply houses have an unnatural colour, and the odour of the preservatives may repel the children.

Models of hearts may be brought in for examination, but be sure to call attention to any exaggeration of size. Some schools own manikins that can be taken apart to show the relation of the heart to other organs. If there is an articulated skeleton it can be used for a few minutes to show the location of the heart and the construction of the chest framework.

When using materials for enrichment, such as those outlined above, remember that their purpose is to give additional experiences; we should not expect mastery of their details.

Sometimes the school doctor or nurse is willing to talk to the children for a few minutes about the treatment of cuts. Sometimes a physical education teacher will talk to them about safety while playing. These new faces and new viewpoints are refreshing to the children. In general, such talks should be very short unless the speaker is experienced in dealing with small children.

TEACHING THE UNIT

This unit may be taught at any time of year. There may be more opportunities for the application of the safety instruction if it is introduced fairly early in the year.

Some useful words have not been used in the book because they are not part of the general vocabulary of children. These are such words as *vein, artery, pulse,* and perhaps—*stethoscope.* However, they are words that the teacher may well introduce into the speaking vocabulary of the children.

Page 65

What are the children and dog doing? Why do you sometimes run fast?

How do you feel after you have been running hard? Are you tired? Do you breathe faster? Do you sweat?

What running games do you play? Where do you play them?

At this time take up some safety precautions for some of these games, particularly those games that are apt to lead the children onto sidewalks and streets. Include safety precautions for the use of bicycles, skates, and the like on streets and highways.

Pages 66–67

These pages deal with respiration. Most pupils at this level have noticed the act of breathing but they rarely think much about it. An actual experiment is the best treatment for this subject. Direct the children to do some form of vigorous exercise such as running, and then call attention to their quick breathing. Ask them to inhale and exhale through their noses and then through their mouths. Ask them to stop breathing and see who can hold his breath the longest.

It is important that children realize that air is involved in breathing. If this concept has been satisfactorily taught in the previous year, review the concept with the activity shown on page 67. Otherwise, select some activities from unit seven of *Exploring Science One* to demonstrate that air comes from our mouths.

For enrichment and to encourage out-of-school observations, ask the children to study the breathing habits of other members of their families and of their pets. **Do babies breathe? Do people breathe when they are asleep? Do any of your pets breathe when they are awake? Do any pets breathe when they are asleep?**

Page 68

Direct the children to read this page. Ask someone to tell the story. **What did John feel thumping inside his chest? Do you feel anything inside your chest? What does the book say it is? What happened to John's heart after he ran?**

Plan to do the experiment that John did. Direct each pupil to put a hand on his chest and whisper "thump-thump-thump-thump" in time with his heart-beat. Lead the class in some form of exercise, such as running around the building, or around the room if it can be done without too much disturbance. Give every pupil an opportunity for the experience. Then ask the pupils to sit down and lay their faces on their desks while they hold their hands on their chests. After a minute or so ask them for their observations. **Were your hearts beating fast after you ran? Do they beat as fast after you rest?**

Ask them to find out if other members of their families have hearts. Ask them to hold their hands on the chests of some of their pets to see if they can feel a heart beating in each one.

Page 69

Review some of the work on the heart. **What beats inside your chest? Does it always beat the same? What makes it beat faster? What makes it beat slower? Where do you feel your heart? Put your hand there.**

Study the picture to see where the heart is. Can you touch your heart with your fingers? Why not? Can you find your ribs? Do they go all round your chest, even in back? Can you find your breastbone? Can you find your collar bones?

Breathe deeply. Do your ribs move? How?

If a skeleton is available take the class to see it or bring it to the room. Hold a model heart in the rib cage in the proper location. If there is not a model heart of the right size, double your fist and hold it in the rib cage, explaining that the heart is just about the same size.

Paper manikins of the skeleton, sold at Hallowe'en time, will show in crude fashion the bones of the chest. Sometimes a chart of the skeleton may be borrowed from a high school science teacher. Do not use these for more than showing the main features of the skeleton.

Discuss the picture of the doctor and what he is doing. **Who has had a doctor do this to him? When? What was the doctor listening to?** If there is a stethoscope put it on the science table so that the pupils can use it on each other.

Pages 70–71

These pages show an experiment with a homemade stethoscope. Ask the pupils to look at the pages and see what is being used. Ask them to bring in washed cans that have been opened by an opener that leaves smooth edges. Show them a sample so they know the size, shape, and condition of the cans wanted. When there are enough cans, carry out the experiment as described on these pages.

Pages 72–73

Where is the heart? Describe an experiment which shows that the heart goes faster sometimes. **Do any animals have hearts? Which ones? How do you know?**

Direct the pupils to read page 72. **What does the heart do? Where does the blood go? When we run and play what happens to our blood?**

Who has seen blood? Where? What colour is it? You may mention at this time that our blood carries food and other necessary things through our bodies, but do not stress it because the pupils do not have a satisfactory background to grasp this concept.

The relation between the heart and the blood can be given more meaning if a fresh heart from the butcher's can be brought in and cut open to show where the blood flows. If possible, get a heart before the veins and arteries have been trimmed off. Do not expect the children to understand how the heart acts; at this level it is enough for them to know that the heart pumps blood.

A dissectible model of a heart is excellent to supplement a dissection because it shows the relation of the chambers and the blood tubes so effectively.

The study of the blood tubes can represent another day's lesson. **What does the book say about the way blood goes to different parts of the body? Look at the backs of your hands. Can you find the faint blue lines that are the blood tubes there?** Explain that these tubes are carrying blood back to the heart. Introduce the word "veins." Have them hold one hand down low and then notice that the veins fill up. Have them hold a hand high and notice that the veins are not so full. The children can find other veins in their arms, legs, and feet. If they are given small mirrors they can see veins under their tongues. The blue colour of veins is not so much due to the colour of the blood within (blood in the veins is crimson rather than scarlet) as it is due to the colour of the veins themselves.

Page 73 deals with the deeper-seated blood tubes that carry blood from the heart to the rest of the body. Introduce the term "arteries," but do not expect all pupils to master the word. Have the children find the pulse in each of the places shown in the pictures. Make an outline drawing of a human figure on the blackboard. With red chalk mark the points where the children can feel blood coursing through the arteries. In addition to those pictured, pupils may feel a pulse in the clefts along the sides of the jaw-bones, in the hollows above the collar bones, and in the hollows of the elbows.

The work of these pages can be enriched with a simplified chart showing the circulation of the blood. Trace the path of the blood from the heart to an arm or a leg and back again.

It does not seem necessary to introduce the term "capillaries" at this time. However, the concept can be established by indicating on the chart how the arteries divide into smaller and smaller tubes, the finest of which unite again to form veins. The finest of these tubes are termed "capillaries."

Pages 74–75

Ask someone to tell the story on the first of these two pages. **Why did blood come from the boy's hand? What is the story told on the second of these two pages? Why was the cut cleaned? Why was the bandage put on?**

Spend some time discussing some dangers in places where the children might play. Some suggestions are: playing rough games near sidewalks and curbs; running on rough gravel or cinders; running with sharp sticks in the hands; carrying open knives; leaving garden and lawn tools where children play; leaving broken glass around.

If possible have a doctor or nurse talk about the care of minor injuries, not so much what the children should do for treatment as why they should ask for treatment.

Page 76

Discuss the need for rest and the ways we can rest. Give attention to the requirements for restful sleeping, such as good beds, clean bedding, ample blankets, quiet rooms, cool (but not necessarily cold) air, fresh air, single beds, early retiring and rising. Explain that we believe children should have about ten hours of sleep at night.

Summary Questions

1. The answer the children will probably give is that we breathe very fast when we exercise. Some may also have noted that they breathe faster when they are frightened or angry or excited in other ways.

2. The heart is almost in the centre of the chest. We usually think of it as being on the left side because the left half of the heart is larger and stronger; this half is the part that sends blood through the main arteries of the body while the right half sends the blood to the lungs.

3. The blood goes through tubes. Some of the children may mention the veins, fewer will mention the arteries. Probably none know about the tiny tubes called capillaries although these are the ones usually injured in minor cuts.

4. We breathe air. Children are not ready for a discussion of oxygen and carbon dioxide; they might use the words but without understanding.

5. We should take good care of cuts so they will heal faster. It does not seem wise to go into serious discussion of infections, blood poisoning, amputations, and other similar subjects.

6. The heart makes the blood move through the blood tubes in the body.

7. We rest best when we can be quiet, and we can be quiet best when we sleep. The children should recognize some of the conditions that make us sleep better.

Follow-up

Review the hazards of active play on two or three occasions. Refer to accidents caused by careless play as they are reported in the newspapers.

Give favourable recognition to children who have had their injuries treated. Look for untreated injuries and see that the children have them attended to.

As pets are brought in, ask the children to notice whether the pets breathe and, if possible, whether the pets have hearts that beat.

POSSIBLE LEARNINGS

We breathe air.
Exercise makes us breathe faster.
Exercise makes our hearts beat faster.
The heart pumps blood through the body.
Blood goes through tubes in the body.

We should take care of cuts so they will heal quickly.

After we exercise we need rest.

When we play we should be careful so we do not injure our bodies.

BIBLIOGRAPHY

Books

Doctor Is Coming. Eva Evans. Hinds: New York, 1947. 23 pages.
The experiences of a young child when the doctor comes to school.

Growing Story. Ruth Krauss. Nelson, Foster and Scott: Toronto, 1947. 32 pages.
A small boy realizes his own growth when he puts on his last year's clothes.

Health Can Be Fun. Munro Leaf. Frederick A. Stokes: New York, 1943. 55 pages.
With his funny drawings the author shows health is not only fun but profitable.

Safety Can Be Fun. Munro Leaf. Frederick A. Stokes: New York, 1938. 49 pages.
Funny pictures show the sad stories of those who disregard safety.

A Time For Sleep. Millicent Selsam. S. J. Reginald Saunders: Toronto, 1953.
Tells how different animals sleep.

Film

Rest That Builds Good Health. Coronet.
Eric and his schoolmates learn why proper amounts of rest are needed, what happens when we sleep, and how to relax and exercise.

Mirrors

PURPOSE OF THE UNIT

A few experiences developing simple concepts of light were provided in *Exploring Science One*, but this is the first unit in the Series dealing exclusively with this important area. This unit will be followed in later grades with units on lenses, colour, sunshine, and vision.

The concepts of reflection developed in this unit will be utilized again, for example, when explaining that moonlight is reflected sunlight.

In this unit we give pupils an opportunity to repeat, and to gain new meanings from, their many out-of-school experiences with mirrors. Experiences of a more advanced nature are then given, these experiences being planned to extend the concepts of reflection into useful areas. A measure of the success of the unit is the extent to which pupils repeat and use these experiences outside of school.

Several important laws of reflection are implied in this unit, laws dealing with the nature of surfaces, the angles of reflection, and reversal of images. However, these laws are not verbalized; pupils have neither the vocabulary nor the background of experiences to permit verbalization of such abstractions at this time.

The unit provides an excellent opportunity for manipulation of materials. The adjustment of angles between mirrors seems simple enough to adults, but much more skill and co-ordination are needed than is usually suspected. One goal of this programme is the development of co-ordination and the kinesthetic sense.

PREPARING FOR THE UNIT

An adequate supply of small mirrors is the chief requirement, at least one for each pair of pupils. The type carried in ladies' handbags, about three by four inches, is excellent. Such mirrors can be purchased, asked for, or cut in a glass shop. The edges of all mirrors should be rounded or covered with gummed tape.

Besides the small mirrors, two larger mirrors, about six by nine inches, are needed for the "hall of mirrors" described on page 87.

The backs of all mirrors may be protected with cardboard attached by the same tape that binds the edges of the mirrors. Otherwise the silver backing is apt to be scratched off. If cardboard is not put on the mirrors, always store them between cardboard separators.

To extend the experiences suggested in the unit, it is helpful to have a number of types of mirrors. A large wall mirror can be used to call attention to hair, faces, and neatness of clothing; it can also be used to study reversal of images. A concave mirror and a convex mirror make interesting additions; the latter is sold as an enlarging mirror by stores selling cosmetics. It is also possible to find "freak" mirrors; metal shaving mirrors can be bent to produce weird distortions.

A triple mirror is a source of endless amusement. Sometimes one can be picked up from a discarded dressing-table. Schools which teach sewing usually have a full-length triple mirror.

Two common toys, periscopes and kaleidoscopes, utilize mirrors. These may be provided for the pupils to play with, and one of each may be taken apart to show the mirrors inside.

List of Materials

Small "pocketbook" mirrors
Larger mirrors about a foot square
Hand-mirrors
Large pan
Candle
Large cardboard carton

TEACHING THE UNIT

There are a number of ways of introducing the study of mirrors. Most desirable are those which take advantage of some event or situation which interests the children. Perhaps a large mirror hung in the classroom to awaken interest in good grooming may provide an excellent opening.

Another method is to raise some problem situation for discussion. An example of such a problem is "How can you see the back of your head?"

The same approach can be put in story form. Tell about the little boy who wanted to know what the back of his head looked like. He could not see it in a mirror, no matter how hard he tried. His mother told him what the back of his head looked like but he wanted to see for himself. Then one day he saw it. How did he do it?

Page 77

If the problem referred to above is used as an introduction, this first page climaxes the discussion and presents a solution. By all means try to give every pupil an opportunity to perform this simple activity. It is not enough to look at pictures and talk about things; true science education involves the use of all senses, including those involved in touch and manipulation. If it is at all possible, the wall mirror and some type of hand-mirror should be provided. The pupils will use them during periods of free time.

Pages 78–79

These and some of the following pages suggest activities for sunny days in a room that faces the sunlight. If the regular classroom does not face properly, try to make arrangements for another room. If all the windows but one can be shaded, better contrast between the reflected light and the walls will result. Page 79 illustrates an experience which many pupils have had. Stress the danger and the lack of courtesy involved in flashing the sunlight in someone's eyes; insist upon simple rules of courtesy and safety in this regard.

The word "reflects" is introduced at this time. It needs no definition here because it is given meaning by the context.

Pages 80–81

Mirrors are not the only things that reflect light. All objects reflect light to a greater or lesser extent. Page 80 deals with a common source of reflections, a smooth pool of water which acts as a mirror.

If a pond, a lily pool, or a quiet stream is not too distant, these pages can be enriched by one or more visits to look at the reflections. It is especially interesting to see the effect of sky conditions on the pool; on clear days the water will seem blue, on cloudy days it will seem gray. Encourage the children to paint pictures showing reflections in the water. The teacher may also take snapshots of the pool to make a record of the reflections.

Page 81 suggests some experiments with reflection by smooth surfaces. A pan of water is used in the illustrated experiment. A pane of glass can be used and likewise a sheet of polished metal. Tin cans, spoons, drinking glasses, and other shiny objects can be tested.

A somewhat artificial and abstract idea is introduced by showing the light as lines with arrows on them. However, this conventional treatment is not hard to grasp and it has certain values, such as indicating that light travels in straight lines and that it moves from a source to other objects.

Pages 82–83

These pages show some applications of mirrors as used to extend the range of vision. Other activities will suggest themselves, including the use of a mirror to look over the top of a desk and the use of a mirror to look into a box.

Page 84

Seeing an object and its reflected image at the same time is not an uncommon experience. This activity helps to develop the concept that light travels from the source to the eye. Too frequently, children have the idea that something travels from the eye to the object when we see it. In this activity light travels *directly* from the candle (the source) to the boy's eye; and light travels *indirectly* from the candle to the boy's eye, being reflected by the mirror.

The experience can be amplified by using several objects in place of the candle. A group of five things is immediately doubled. New, symmetrical patterns result when a few objects in some simple arrangement are viewed in the mirror.

Page 85

The concept that light can be reflected more than once is a new one to many children. It is an important one, however, because things that are not light sources themselves are often visible to us because of repeated reflections of light.

The children will enjoy trying to reflect light twice as illustrated. With patience they can reflect light three times and even more.

A periscope may be studied at this time. Try to have one to take apart and one or more to play with.

Pages 86–87

Multiple reflections such as those shown on these two pages are entertaining. The kaleidoscope is a toy utilizing multiple reflections of this type. One may be put on the science table for the pupils to use, and another may be taken apart to show how the mirrors are arranged.

A triple mirror is a device depending upon multiple reflections. If possible take the class to see one at this time.

Pages 88–89

In addition to the uses of mirrors suggested here, pupils will probably suggest others. There are reflectors in flashlights and in automobile headlamps. Elevator operators use mirrors to see if there is anyone waiting just beyond the door of the elevator. Try to duplicate as many of these uses of mirrors as possible.

Page 90

Most children have seen reflecting highway signs. If there is one near the school take the class to see what it is like. Sometimes a damaged one can be procured from the proper authorities. (There are signs made with luminous paint which do not use reflections; in these signs the paint glows.)

There are other reflectors of a like nature. Most common are the red ones used on the backs of bicycles. One of these can be brought into the classroom. If the room can be darkened, shine a flashlight beam on the reflector to make it gleam.

At this time the children might be asked if they have seen cat's eyes gleam when headlights shine on them. The children may have also noticed the eyes of other animals gleam. Each eye of such animals has a reflecting surface at the back of the eyeball.

Summary Questions

1. A mirror reflects light; light strikes it and "bounces" off.
2. In a broad sense, everything more or less reflects light. At this time it is enough for the children to mention such shiny things as glass, still water, metal, varnished wood, smooth paint, and so on.
3. Let the children answer this question by demonstrating with two mirrors.
4. Again let them demonstrate with one mirror, with two mirrors, and with a periscope.
5. Let them demonstrate.
6. The uses given on pages 78, 79, and 80, together with others in their experience, make a satisfactory answer.

Follow-up

There are often opportunities to call attention to reflections. Sometimes windshields of cars throw a flash of reflected sunlight into the room. Sometimes the surface of an aquarium produces a spot of light on the ceiling.

Reflections can be seen in windows of stores, houses, and autos. Pools of water reflect the skyline. When the class is taking a walk with an entirely different objective, time may be taken to call attention to these things.

Repeated used of the word "reflect," as applied to the many situations noted above, will make it part of the vocabulary of the children.

POSSIBLE LEARNINGS

Mirrors reflect light.
Anything that is smooth and shiny reflects light.
Light can be reflected more than once.
We use mirrors to see things that are out of the range of vision.
Mirrors are useful in many ways.

BIBLIOGRAPHY

Books

Experiments in Optical Illusion. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1951. 114 pages.

The teacher will find this useful for its suggested activities and experiments.

Experiments in Science. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1947. 116 pages.

A collection of experiments which can be carried out with simple equipment.

Film

Light and Heat. Gateway.

Extends understandings of reflected light; shows what light and heat do for us.

Fun with a Dry Cell

PURPOSE OF THE UNIT

Magnetism was introduced in *Exploring Science One.* The study of electricity is introduced in this unit. Through the succeeding books of the Series the concepts of magnetism and electricity are extended, building understandings that are important in a society dependent upon electrical energy.

This is a "do" unit. The learnings are based almost entirely upon activities. Such first-hand learnings are almost indelible—worth immeasurably more than hours of talking and reading. In addition, as we give pupils opportunities to "do," there are always many learnings not deliberately planned, such as an appreciation of the malleability of copper wire and the leverage of a pair of pliers.

The unit will be of great help in developing the ability to follow directions. If a child fails to remove the covering from a piece of wire his experiment fails; but if he gives attention to the few steps in the procedure as outlined he has success and a feeling of accomplishment. It is, of course, possible for the teacher to give children help when things go wrong, but too much interference denies the children an opportunity to become self-reliant.

Do not let boys dominate the activities of this unit. Girls have as much innate manipulative ability as boys, but they usually develop it less extensively. At this early level let the two sexes differ but little in their manipulative abilities, allowing teachers an opportunity to help girls to feel more assurance in mechanical manipulation.

PREPARING FOR THE UNIT

Ideally there should be at least one dry cell for two pupils. This may seem expensive at first thought, but dry cells are needed for the fifth and sixth grades; and in schools where the upper grades are in the same building, all the upper grades should have dry cells. On a per pupil basis the expense of buying so many dry cells is small.

However, it is possible to use fewer numbers of dry cells. Let individual pupils demonstrate connections to the others of the group. Then put the necessary equipment on a table where all pupils can experiment as they find the free time.

The teacher should insist that whenever pupils are through with the dry cells they disconnect all the wires; attached wires sometimes touch each other and cause "short circuits" that quickly ruin a dry cell.

The size of wire that seems best for this level is No. 24, double cotton-covered copper wire, usually handled by radio and electrical stores. Bell wire is a little too stiff for small hands.

Miniature light sockets, bulbs, and buzzers can be purchased in radio or electrical stores. Be sure to explain how these are to be used so that the right kind will be provided.

The small screwdrivers, one for each pair of pupils, are inexpensive, but the pliers should be good ones even if no more than one pair can be bought. Pupils do not have hands strong enough to cut wire with dull pliers. Side-cutting pliers are best for wire cutting.

When putting away apparatus, see that all screws and binding-post nuts are screwed on tightly so none will be lost. Keep the dry cells in a rather cool place but not in a damp cellar.

List of Materials

Dry cells
Wire-cutting pliers
Scissors
Miniature sockets
Flashlight bulbs
Insulated wire
Electric bells
Cardboard carton
Flashlight

TEACHING THE UNIT

As said before, this is a "do" unit so let the children carry out the activities again and again. Much of the activity will take place during free time and certain pupils will participate more than others. The classroom needs a relaxed, informal atmosphere for this unit.

Little discussion is required or even possible with this unit. But it is not necessary to verbalize in order to know a great deal about science. So do not be concerned if no "points" seem to have been put across just because the children do not talk about them.

Should pupils ask "What is electricity?" it is well to say simply "I do not know." As yet there are only theories about the nature of electricity, theories that explain some things very well but which have not been completely proven. To children on this level the nature of electricity may very well be mystifying. However, its importance and many uses will not be.

Page 91

What is happening on this page? What does the girl have in her hands? To what are the wires fastened? To what is she touching the wires? How many wires has she? What happens when she touches the wires to the electric lamp? What tools does she use?

Would you like to do what the girl is doing? Look at the next four pages; they will tell you what to do.

Pages 92–93

These pages show techniques of handling wire. Pupils usually skim them rapidly and go on to the more exciting pages beyond, but they return when they realize the need for the techniques shown.

Ask a few questions to be sure that the children know what is on the pages. For example: **What tools are shown on the pages? What is being done to the wire in the first picture? What has been done to the wire in the last picture?**

The covering on the wire is technically called "insulation." The children do not need the word for understanding of this unit. If the word is introduced it might be well to wait until after the children have carried out the first activity.

Pages 94–95

What things do you need to make the lamp light? Give out the materials to the pupils, preferably enough for each pair of pupils to carry out the activity separately. Otherwise ask individual pupils to take the materials and demonstrate procedures to the rest of the class.

Give as little help as possible. Be sure that girls have opportunities equal to those of the boys. Allow time for repetitions of the experiments if the pupils desire it.

Leave one set of materials on a side table for experimentation during free time. Impress upon the pupils that they must always remove the wires from the dry cells when they are through with them. They should also turn down the binding-post nuts and the screws.

Pages 96–97

Precede the work on these pages with a short review. **From what did the electricity come in the last experiment? Through what did the electricity go? How many wires were used? What had to be done to the wires before they could be used? What did the electricity do to the lamp? Open your books to pages 96 and 97. What do these pages tell? What will you need for this day's work?**

Give out the materials as for the preceding activity. Allow adequate time for repetition of the experiment as the children wish it. When the children are through, be sure they take care of the materials properly. As before, leave one set of materials out for free-time activity.

For a variation on this activity, give the class two pieces of wire fifteen or twenty feet long. Direct them to put the dry cell on one side of the room and the buzzer on the other. Ask them to connect the wires so that the buzzer will buzz. Children like to make the buzzer sound from a distance. They may also lead the wires under the door into the hall and pretend that they have a door-bell circuit.

Pages 98–99

This is a class project or a project for group activity. Ask the pupils to study the pages and see what is needed and what is to be done.

The house shown in the picture is made of a carton. Wooden boxes and orange crates may also be used with some adaptations of the methods shown here. A commercial doll house may be used, but the children enjoy making their own.

The most serious difficulty encountered in this project is fastening the wires to the screws. Children can handle the screwdrivers, but they are as apt to unscrew as tighten a screw. When the screw comes out they are not usually able to put it back again; the teacher must help them.

After the doll house is completed the children will enjoy seeing it lighted in a darkened room.

Pages 100–101

These are discussion pages dealing with common uses of electricity. The children usually know of uses other than those illustrated.

Ask the pupils what would be used in each case if there were no electricity. Sometimes they will not know but they will know in enough cases to realize something of the great advantage of electricity.

Ask them how each device is turned on—where the switch is. It is not necessary to explain the construction of switches at this time.

The children may cut out pictures of electrical devices and make them into a bulletin board display.

Page 102

Show a flashlight and turn it on. **What makes a flashlight light?** If the pupils have seen a flashlight taken apart ask them to tell what they have seen. Then study the diagram on this page.

Take the flashlight apart and show the different parts. The small cells are dry cells much like those the children have used except for size and lack of binding-posts. Connections are made by metal parts touching each other instead. The lamp itself is the same. There is a switch to make the lamp light.

It is not necessary to explain the construction and the circuit inside the flashlight at this time. It is enough to know that dry cells and miniature lamps are used.

Summary Questions

1. Dry cells usually have two binding-posts. The exceptions are those used in flashlights. These have no binding-posts.
2. Bells and buzzers have two binding-posts.
3. The children used two wires to light their lamps. Sometimes metal objects other than wires are used for part of a circuit, but the children would have no experience with these situations.
4. For the children, the electricity lighted lamps and sounded bells or buzzers. If the unit was enriched with electrical toys, then other answers will be acceptable.
5. The answers given here will vary greatly depending upon the home situations of the children and how observant they are.

Follow-up

An excellent follow-up for this unit is to plan an electrical display for the parents, for a P.T.A. meeting or an open house evening. Besides the simple light and buzzer circuits the children can display lighted doll houses, stores, and other model buildings. They can display posters on the uses of electricity. They can display different kinds of flashlights and electrical devices.

For general follow-up, occasionally put out the materials needed for an earlier activity and let the children repeat the experiences as they wish.

POSSIBLE LEARNINGS

Electricity moves through metal wires.
Electricity will not go through cloth covering on wires.
Two conductors are needed for an electric circuit.
Electricity can light lamps and sound buzzers.
Electricity does many things to help us in our homes.
Electricity can be stopped and started.
Electricity in our homes is dangerous to play with.

BIBLIOGRAPHY

Books

A Boy and a Battery. Raymond Yates. Musson: Toronto, 1942. 120 pages.

A useful book for the teacher, suggesting experiments with simple materials.

Working with Electricity. Katherine Keelor. Brett-Macmillan: Toronto, 1929. 111 pages.

The teacher will find help in introducing young children to electricity.

Buds

PURPOSE OF THE UNIT

Plant study is an important phase of science, and each book of the Exploring Science Series provides experiences through which children may learn some important principles of plant life. In *Exploring Science One* the children studied seeds; they noted the seasonal loss of leaves by many woody plants, and the seasonal renewal of growth by plants, including the development of leaves and flowers from the buds of woody plants. This unit takes up in more detail the last of these items, building upon the experiences provided in *Exploring Science One*.

Fundamentally this unit deals with the breaking of winter dormancy in woody plants. One factor only, that of temperature, is considered. The role of the rest of the plant in providing water and additional supplies of food is implied, but will be studied in more detail in later grades.

Identification of woody plants is not stressed, nor is classification. However, children will come to associate names with the twigs being studied and they will note similarities of leaves and flowers.

As in most units dealing with living things, this one touches upon interrelationships. The children will learn how certain animals depend upon the buds of plants for winter food.

In addition to the pure subject-matter aspects, this unit helps make children more aware of, and more interested in, events out of doors. An increased consciousness of the environment, greater curiosity about it, and more use of the senses are important outcomes of the science programme.

PREPARING FOR THE UNIT

The teacher will be greatly aided by some knowledge of the location of certain trees and shrubs in the neighbourhood of the school. This information may be acquired in the fall while leaves are still on the plants. One may also ask for such information from home owners, biology and agriculture teachers, and scout leaders.

Some species are well suited for the indoor study of buds. Among these are the following common types:

Forsythia—large yellow flowers that appear early
Cultivated cherry—white flowers that appear before the leaves
Pussy willow—both wild and cultivated kinds
Trembling aspen—fuzzy catkins like those of pussy willow
Lilac—large buds, both leaves and flowers will begin to develop
Horse chestnut—large, easily studied buds.

The unit is best taught in early spring, about the time that the pussy willows and the aspen buds begin to burst their coverings. Buds brought indoors at this time open rapidly, whereas buds brought in earlier need more time for development.

Aside from the buds themselves few materials are needed. A sharp knife helps cut the twigs. Hand lenses help in the study of the buds. Jars and vases are needed for the twigs, and it is helpful to have enough small half-pint jars or baby-food jars so that each child can have his own specimen for observation. Pictures of woody plants in flower and fruit serve as supplementary sources of information.

List of Materials

Glass jars
Sharp knife or pruning shears
Hand lenses

TEACHING THE UNIT

This unit may well be given two or three weeks of intensive work in regular science periods. Then it should have a long period of follow-up during which the development of buds in the classroom is noted and observations made of corresponding development outdoors. Most of the follow-up work is in the nature of incidental teaching.

Page 103

One can begin with a study of this page. **What is the girl looking at? What are the little bumps on the twigs called? Where did the twigs come from? What may grow from the buds?**

Does the tree outside the window have buds on it? How about the trees outside our school? Do all trees have buds on them? How could we find out?

What was on the trees last summer? When did the leaves fall off? When will the leaves grow again?

Pages 104–105

These pages show two kinds of twigs that will produce flowers when brought indoors; the twigs on the left are from a forsythia bush and the ones on the right are from a domesticated cherry tree. The flowering buds are usually larger and are clustered; leaf buds are single and smaller.

It is well for the teacher to collect these twigs ahead of time and talk over with the children the problems of home owners who are trying to raise the shrubs and trees for their own use so that the children have a feeling for the property rights of others.

If possible, have enough twigs of one kind so that each pupil may have his own specimen to watch. Give them small glass jars in which to put them. The children may put their names on labels on the jars.

In an area where there are numerous wild shrubs, take the children on a trip to collect twigs. The teacher should cut the twigs with a sharp knife and give the children the twigs to carry. Bring back several different kinds.

It is well to study a few twigs for a few days until the children are familiar with them and then bring in new kinds. Besides the children's individual twigs, one may have five or six other kinds developing in the classroom.

Pages 106–107

These pages set a problem for the pupils to answer by direct observations. A lilac twig like that on the left-hand page may develop flowers from some buds and leaves from others. Twigs such as this one may be brought indoors and kept in water. The buds will open and both flowers and leaves will begin to develop, although they will not become full size. Similar twigs may be watched on the plants if some are near the school.

While the children are waiting for the buds to open naturally they may open some large lilac buds. They will see that leaves have been present in the buds and that they need only to grow larger.

Page 108

This page shows buds of two other woody plants. Many people think that flowers are always showy structures complete with petals. However, many flowers are very different from the popular conception. Aspen and willow flowers are in drooping clusters called "catkins." There are male catkins which produce pollen, and on separate plants there are female catkins that produce seeds. The male catkins are larger and develop more rapidly; they are more satisfactory for classroom use at this level.

In addition to having the twigs in the classroom try to take the children to see the plants in bloom outdoors. Both of these plants are common; cultivated varieties of pussy willows are much used around homes.

Page 109

People often forget that evergreen trees also have buds. It is interesting to select a twig on an evergreen tree for study and watch it through the spring season. Children will thus gain an idea of how evergreen trees grow.

Picture No. 1 shows a twig of a pine tree as it might look in late winter with the bud unopened. Picture No. 2 gives the early spring appearance with the bud opened and the twig elongating. Picture No. 3 shows the late summer appearance: the twig has grown several inches, flowers have formed, and cones (which are the fruits of the pine tree) have developed from some of the flowers.

Pages 110–111

These pages extend the concept of bud growth into the fruiting stage. The apple is chosen as a type. Ask the pupils to read the picture story and the text. Then ask them to tell the story.

It is often possible to watch the early stages of an apple as shown on these pages. A tree near the school can be visited several times during the spring. By the time school is out, small green apples will have developed.

As part of this study, bring in an apple and cut it open to show the seeds. Then let the children tell the story of how an apple tree may come to grow.

Pages 112–113

These pages give stories of twigs of some other fruit trees—peaches on page 112, oranges and lemons on page 113. When possible take the children to see some of these trees. Even in northern climates many people raise lemon trees as house plants and are willing to show the children what the trees look like. One may also supplement these pages with pictures of different kinds of fruit orchards.

Pages 114–115

The food stored in buds and used for leaf or blossom growth is sometimes used by animals. On these pages are shown the ruffed grouse, or "partridge," a bird of the cooler wooded areas of Canada, and the deer and the rabbit. These animals feed extensively on buds and twigs during the winter. The interrelationship of these living things can be discussed. The animals are benefited by having a supply of food when many foods are scarce. The plants are harmed if there are enough animals to strip them of their buds.

Page 116

The unit has dealt with the buds of woody plants, but to be sure that children realize that other plants also have buds brief study of a potato has been included. In late winter, potatoes usually start to sprout. If some of these sprouting potatoes can be brought in the children can watch the development of the plant. A potato may be planted in soil. A potato will also grow if suspended over a glass of water in such a way that the roots touch the water.

Summary Questions

1. Leaves or flowers or both may grow from buds. New growths of twigs also come from the buds at the ends of the twigs.

2. Buds usually open in the spring. When leaves are stripped from trees early in the season, as by insect infestation, buds may open in the summer. Leaf buds on new growth often open during the summer.

3. Buds will open sooner if put in a warm place.

4. Deer, rabbits, and some kinds of birds eat buds in winter. In other seasons there is a plentiful supply of foods other than buds.

5. Three buds are covered by scales. Some are covered with down and others with a substance almost like varnish.

Follow-up

The time needed for buds to develop depends upon the species and upon the length of time the buds have been dormant. Buds gathered in mid-winter may take two or three weeks to develop. On the other hand, trembling aspen buds gathered as they begin to open outdoors, will be in full bloom in two or three days. In any event, the buds will precede natural development outdoors and so after the formal study is over they will stimulate continued observation of woody plants all spring. The possibilities for continued study are limited only by the time the teacher wishes to give.

POSSIBLE LEARNINGS

Buds of woody plants contain the parts that will grow from them.
Flowers or leaves or both come from the buds of woody plants.
Increased temperatures make buds open sooner than normal.
Fruits develop from flowers which grow from buds.
Some animals feed on buds in winter.

BIBLIOGRAPHY

Books

Play with Trees. Millicent Selsam. George J. McLeod: Toronto, 1950. 64 pages.

A first book about trees, including their buds and flowers.

Films

Glory of Spring. Ontario Department of Education.

The blossoming of shrubs and trees from winter buds is shown by time-lapse photography.

In the Spring. Young America Films.

Spring is an Adventure. Ontario Department of Education.
A young girl watching typical spring activities.

Rust

PURPOSE OF THE UNIT

Let us paraphrase an old saying to read "Conservation begins at home." Children need opportunities to practise conservation. They can do nothing about the now-extinct passenger pigeon and they can do nothing about our vanishing forests. But children can learn to conserve the things made of steel. Our iron ore reserves are being seriously depleted, and we are nearing the end of some of the deposits of coal that are satisfactory for blast furnaces. All of us should be thinking in terms of the conservation of these important minerals.

The children will be studying chemistry in this unit—the chemistry of oxidation. Of course the terms "chemistry" and "oxygen" are not used at this time, but the experiences gained make a foundation for later understanding of oxidation.

Water is an important factor in the rusting of iron although children cannot fully appreciate its role. When iron oxidizes in dry air it becomes covered with a thin coating of oxide that shuts off further oxidation by keeping oxygen away from the metal. But if there is moisture present, the oxide unites with the moisture to make a soft, crumbling coat. This coat flakes off easily and exposes more of the metal to the air. It is the soft material we call "rust."

In this unit the term "iron" is formally introduced and a test for it, magnetic attraction, is used to identify it. There may be some confusion between the words "iron" and "steel." Steel is iron containing small amounts of other things, usually carbon, that change its properties, usually making it harder and tougher.

This unit makes use of controlled experiments. Although simple controlled experiments have been suggested previously in this Series, this is the first time so many have been used together. The controlled experiment, in which one factor is varied, the other factors held constant, is the heart of the scientific method. We want pupils to have much experience with it.

PREPARING FOR THE UNIT

The essential materials needed are some new, unrusted nails, some machine oil or vaseline, and a few magnets. If it is desired to experiment with paint as a preventative for rust, a small can of quick-drying paint should be added to the list.

Sometimes new nails have been coated with an oil to reduce rusting. These nails will not give good results in the experiments unless the oil is removed. This may be done with carbon tetrachloride or with soap and warm water.

The teacher should be on the alert for rusted objects that can be brought into the classroom, and for larger objects that may be seen on field trips. Roadside dumps, junk yards, and vacant lots yield rusted iron. An abandoned and disintegrating automobile shows the effects of rust and the role of paint and grease in preventing rust.

The unit may be taught at any time during the year.

List of Materials

New nails
Glass jars
Labels
Sand
Rusty tools
Rusty cans
A strong magnet
Lubricating oil

TEACHING THE UNIT

Any number of situations might serve as an introduction for this unit—rusting machinery seen on a field trip, a rusty knife or tool that is brought to school, a tool that becomes rusty because someone spilled water on it and forgot to dry it. The unit may also be started with a study of the title page. It is a flexible unit, it can be taught at any time and the different sections of it can be taught in almost any order.

Page 117

Open with a discussion of the picture. **Which boy has the better-looking wagon? Why does one wagon look better than the other? Does anyone have a rusty wagon like the one in the picture? Did it once look like the other wagon? Where was the wagon kept? Does anyone know why it became rusty?**

Pages 118–119

This is a picture story for the children to read and then tell. Talk about the story. **When did Tom leave the knife on the sidewalk? What happened during the night? When did Tom find his knife? What happened to the knife?**

Show the class some rusty objects including a jack-knife if possible. Ask who has rusty things at home. Make plans for a display of some of these rusty objects. Encourage the children to tell of their own experiences.

Page 120

This is a controlled experiment. Note the two nails that are kept in the dry place. These are the "checks" or the "controls."

Interest will be higher if each pupil or each pair of pupils carries out individual experiments. The materials needed are simple and easily provided. Ask the children to determine what is needed and how they are to carry out the experiment. Then give them the materials.

The dry sand should be truly dry; it may be dried in a pan over a radiator for several hours. The other jar of sand should be damp but not so wet that water stands in it.

After a day or two the nails may be taken from the sand and compared. Then they may be replaced and examined at intervals for several days.

Page 121

This activity points up the discussion of the damage that rust can do. It shows that rusting is progressive and that it continues as long as conditions are suitable or until the iron is rusted away. Cans such as these can be found on dumps; badly rusted ones can be found in vacant lots or along roadsides where people throw rubbish. Perhaps a trip can be taken to find cans that show different stages of rusting.

A display of rusted objects may now be organized. Try to include tools such as saws and wrenches that are worthless because rusting progressed so far.

A trip to look for rust spots on automobiles is appropriate at this time.

Pages 122–123

These pages are designed to start discussions of how people may keep things from rusting by proper storage. Note the man wiping damp soil from his tools. Centre the discussion as much as possible about what the children themselves may do to prevent rusting.

Pages 124–125

Here we have an experiment that shows that some things do not rust. Any number of things can be tested besides the coins and nails suggested. Children can try glass, wood, rubber, and many different metals. Some of the things tested may change in the presence of moisture but they will not develop the reddish brown colour of iron rust.

Then the children can be shown a test for things made of iron. The word "iron" is introduced in the text, but the teacher should explain that the word "steel" means almost the same thing.

If there is an exhibit of rusty things, direct the children to test each one to see if it is made of iron. Perhaps a trip to a pile of junk can be taken and the children can again test rusty things to see if they are made of iron.

Although it will be found that all rusty things are made of iron they will find that some things made of iron are not rusty. This may be because the iron has been kept dry. It may be because the iron is protected with oil, paint, or some other coating. Or it may be because the iron contains some other substance that prevents rust as in the case of stainless steel.

Page 126

Again we have a controlled experiment. The two nails that are not coated with oil are the control. See if some of the pupils can grasp the need for the control in this experiment.

Page 127

This page shows how oil is sometimes used to prevent rust. Farm children may know of other examples, such as oiling ploughs and shovels before putting them away for the winter. It may be necessary to talk about dampness in the air to explain why things may rust in cellars and in sheds where rain does not fall on the tools.

Page 128

This page can start a discussion of why iron things are often painted. Children can realize that the paint keeps rain water and dampness from the iron.

The discussion may suggest an experiment. Clean nails may be painted with a quick-drying paint, and when dry put in wet sand. See if the children will suggest putting in some unpainted nails as a control.

Summary Questions

1. Things that rust are made of iron. The word "steel" is also correct.

2. Tools should be kept in a dry place because water or moisture in the air causes rusting, and rust damages the tools.

3. A magnet can be used to tell if things are made of iron.

4. Oil keeps moisture from the surfaces on which it is rubbed.

5. No substance except iron rusts; pupils can name many things.

Follow-up

The follow-up should take advantage of unplanned situations. If rusty objects are seen on trips, they can be pointed out and talked about briefly. Sometimes a tool becomes rusty because of careless treatment, and then time should be taken to consider why the tool rusted and how the rust could have been prevented. Such incidental teachings can be very effective when combined with the planned work already described.

POSSIBLE LEARNINGS

Things made of iron often rust.
Many other things do not rust.
Moisture makes iron rust.
Oil and paint are used to keep moisture from iron.
A magnet tells us if something is made of iron.
If rusting continues, iron objects are badly damaged.

BIBLIOGRAPHY

Book

Experiments in Chemistry. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1952. 152 pages.

A section on *corrosion* suggests experiments that the teacher may adapt to lower grades.

Film

Chemistry. Gateway.

Rust is used as an example of chemical change in this excellent film for primary-grade children.

Moving Things More Easily

PURPOSE OF THE UNIT

The area of mechanics is an important one in a society dependent upon machines. Children need a fundamental knowledge of the principles underlying the many common tools and other labour-saving devices which make up so much of our environment.

In the Exploring Science Series there is a carefully planned sequence of experiences in the field of mechanics. *Exploring Science One* introduces children to the simple pulley; *Exploring Science Two* shows ways of reducing friction; later the Series will acquaint the children with the lever, the screw, and many other devices.

This study involves much manipulation, giving children a chance to make things, to learn through touch and muscular effort, and to develop ingenuity by working out variations on the activities suggested.

The section on lubrication has immediate values. Too few people ever learn why lubrication is so important to moving parts. We are trying at this time to encourage children to keep their own toys lubricated in order to prevent excessive wear to the moving parts.

PREPARING FOR THE UNIT

This unit may be taught at any time of year. It needs no special introduction and no advance preparation beyond gathering a few materials for some of the activities.

The materials that cannot be found in the usual classroom include spools, cheese boxes or other boxes of similar size and shape, some large nails, marbles, tin can lids, and a board. Useful for enrichment are toys with wheels, a roller skate to show how a ball bearing is used, and some ball bearings from bicycles or automobiles.

A teacher may ask at a nearby garage if someone is willing to take the front wheel from a car to show how the wheel turns on a ball bearing. It may also be possible to show how an automobile is lubricated at a service station.

List of Materials

Round sticks
Round sticks of chalk
Six-sided pencils
Modelling clay
Spools

Large nails
Rubber bands
Cheese boxes
Board
Roller skates or other toys with ball bearings
Can lids
Marbles
Lubricating oil

TEACHING THE UNIT

In a unit like this one it is wise to have most of the materials on hand before beginning work. Then the study can progress without lengthy delays while materials are collected. However, the work should not be rushed. One should give all children an opportunity to participate and one should be careful that girls share equally with the boys in all construction activities. There should also be periods during which the applications of the devices studied are discussed.

Page 129

This page suggests some ways that things can be moved more easily, the freight in the truck and the children themselves.

Is it easier to skate or to run? Which is faster? Is it easier to push a scooter or to run?

How many have ridden bicycles? If you go to the store is it easier to run or use a bicycle? Which is faster?

Is it easier to carry things or put them in a truck? What does the truck run on? What are some other ways we carry things besides using trucks? Which of these ways use wheels?

The boy riding his scooter onto the main road is a boy unschooled in safety. If the class has not already noticed him, ask them if anyone in this picture is doing something wrong.

Pages 130–131

Most children will be able to interpret the pictures without help from the printed text. Let them look at the pictures and tell the story. Then ask them to read the text and see if it helps to clarify the story.

Some children may have seen buildings being moved and they will be able to describe their experiences to the rest of the class.

Page 132

Allow plenty of time for this activity and be sure that all pupils have a chance to perform it. Let them discover that the pencils keep rolling out from under the books. Let them find out how to use three pencils in such a way that the books keep moving across a table. Let them explain their discovery in terms of moving a house.

Page 133

This activity gives pupils a chance to find out for themselves what makes the best rollers. They should arrive at the conclusion that round objects strong enough to support the weight of the load make the best rollers.

Larger scale experiments are sometimes more effective as teaching devices. Put an orange crate on the floor and fill it with books. Have several pupils try to drag it across the floor. Then empty the crate and put it on three sections sawed from a broomstick. Again fill it with books and note how easily it can be moved.

Pages 134–135

Two standard-sized spools slipped over large nails will just fit inside a cheese box. The pupils should have no difficulty with the construction of this toy.

From this work the children should appreciate the advantage of the wheel over the roller.

Pages 136–137

Here are two controlled experiments in which the advantage of rolling on wheels is compared with sliding.

Give the children an opportunity to tell about things that slide and things that roll, where each method is used, and which method is used most.

Page 138

The word "bearing" is used several times on the next few pages. It should be introduced carefully at this time. When a wheel turns it moves round a central support that is usually called an axle. The region where the wheel bears on the axle is called a "bearing." In the toy that the pupils made earlier the bearing was the place where the spool turned on the nail.

Commonly, the wheel slides round on the axle as it turns, but when heavy loads are used such bearings wear rapidly. To reduce the wear and to make turning easier, ball bearings have been invented and these are described here. Sometimes "roller bearings," in which rollers are used instead of balls, are found where loads are very heavy.

Try to show the children a ball bearing in a roller skate; some skates have enclosed bearings that cannot be seen, but in most skates the balls can be seen. The teacher may also show bearings from bicycles and automobiles. Sometimes an older boy will remove the wheel from a bicycle and show the bearings inside.

Pages 139–140–141

These activities give pupils a chance to see for themselves why ball bearings are helpful. The only problem is that of finding can lids of the proper size. Once a set has been assembled it is well to put them in a labelled box and keep them for future years.

If possible, take the class to a garage where arrangements have been made for a mechanic to take the wheel from an automobile and show the ball bearings that make the wheel turn easily. After the mechanic has re-assembled the wheel let the pupils see how easily it turns.

Pages 142–143

The experiment with the oil and the glass will surprise the children because of the effect of the oil on even so smooth a surface as glass. It will help children understand why we use oil on bearings. Try grease in place of the oil—vaseline or lubricating grease may be used.

Sometimes a toy with dry bearings can be found. Ask the children to turn the wheels. Then oil the bearings and ask the children to turn the wheels again. The change is often remarkable.

If possible, bring in the toys shown on page 143 and let the children decide where the bearings are and how the oil should be applied.

Page 144

Some children have seen an automobile being lubricated; others have not. Let the ones who have seen the process describe it. They should understand now why lubrication is done. If possible take the class to see a car being lubricated. They will enjoy seeing the automobile being raised, grease put in the running gear, and oil put in the engine.

Sometimes it is possible to show the children how other devices are lubricated. Someone may be willing to take a wheel from a lawnmower and show the grease inside. The bicycle and the automobile wheels have already been mentioned. Heavy construction machinery, tractors, and farm machinery usually show evidences of lubrication.

Summary Questions

1. It is easier to move heavy things with rollers than to slide them along.

2. Wheels are better than rollers because we do not have to keep replacing them as we do rollers.

3. Ball bearings are bearings that turn on little steel balls.

4. Skates, bicycles, automobiles, and whatever other devices that the children have discovered are made with ball bearings.

5. Oil makes bearings turn more easily.

Follow-up

Follow-up for this unit is a matter of continuing to call attention to applications of the principles already studied. Some of these applications have been mentioned. Others depend so much on local situations that they cannot be enumerated here, but often a hasty glance around the neighbourhood, the school shop, and among the children's own toys reveals many applications worth considering.

POSSIBLE LEARNINGS

It is usually easier to move things on wheels or rollers than to slide them.

Ball bearings help wheels turn more easily.

Oil and grease keep bearings from wearing so fast and they make it easier to turn the bearings.

BIBLIOGRAPHY

Books

Experiments in Science. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1947. 116 pages.

A collection of experiments which can be carried out with simple equipment.

How Things Work. Creighton Peet. Clarke, Irwin: Toronto, 1941. 115 pages.

Interesting information about elementary mechanics.

I'll Show You How It Happens. Marie Neurath. Chanticleer Press: New York, 1949. 32 pages.

Answers many natural questions in simple text with illustrations.

Now Try This. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1947. 40 pages.

Experiments with friction and wheels, using commonplace materials.

Film

Machines. Gateway.
Machines and how they lighten man's work. A film for very young children.

Birds' Eggs

PURPOSE OF THE UNIT

Bird study is of general interest to young and old alike. We cannot and should not expect young children to show great interest in identification of birds, but we can be certain of their enjoyment of the study of the habits of birds.

Habits of observation can be developed with this unit. The robin is a common bird of dooryards and vacant lots in most of the country. It is not particularly shy and it is reasonably conspicuous as it sits on wires and fences. As children watch for it they will also see the dooryard birds common to their localities—sparrows, or mocking birds, or house finches depending upon where they live. As they learn about the robin from their study of this unit they will look for similarities and differences in appearance and habits of other species.

The unit helps children develop a sympathetic understanding of the problems of birds. A teacher should stress the dangers of approaching nests too closely and too often. Children should be cautioned against disturbing nests, eggs and nestlings, and of injuring parent birds. On the other hand the teacher should not be overly sentimental about birds. We do not want children to become prejudiced against the natural enemies of birds. And we do not want them to eventually sicken from an overdose of sentiment, and swing to a cynical, unpitying extreme.

The unit is essentially a study of reproduction and continues the work of *Exploring Science One* in that sequence. Seeds were introduced in the first book of this Series and are touched upon again in the third book. Animal reproduction was touched upon in units on caterpillars and grasshoppers and will be extended to amphibians, reptiles, and fish in later grades. A goal of this Series is the development of a matter-of-fact attitude toward some common manifestations of sex and sexual reproduction. This is done by introducing sex differences and sex characteristics early in the programme and treating the subject as being comparable with digestion and respiration.

PREPARING FOR THE UNIT

The time for this study to begin is when the robin or some other common bird is beginning to build nests. The approximate date varies with the locality and must be determined by experience or by asking local bird enthusiasts.

It is well to talk with local people who are interested in birds. They may have many suggestions about places to visit and things to do to make the subject more interesting to children.

The materials needed are some hens' eggs, a cooking dish, and a hot-plate or other source of heat, and a knife. It is helpful to have some old bird nests to show the children how the nests are constructed and what is used. These nests should be collected in early winter when there is no danger of taking a nest that is in use. The nests may be stored in shoe boxes.

Upon inquiry a teacher may find a family that raises chickens in an incubator. Perhaps a trip to see the young chickens and the incubator can be arranged.

List of Materials

Old birds' nests
Hens' eggs
Saucers
Hot-plate
Small kettle
Knife

TEACHING THE UNIT

This unit may be opened with a story, a moving picture, slides, or a trip to see a nest. It may also be opened by bringing in an old birds' nest to help the children recall any of their experiences with nesting birds.

Page 145

This title page serves a double purpose. It tells where the robin builds its nest, and it shows pupils how to watch a bird.

A number of questions suggests themselves. **What are the children looking at? What do the birds have in their bills? Grass. What do you think they will do with them? Nest-building.**

Conservation and humaneness are encouraged by questioning the pupils about the best behaviour for the boy and the girl. **What might happen if the children move? What would happen if they should**

walk up to the tree where the bird is building the nest? What would happen if they stayed by the tree? What would happen if they went there too often?

A teacher should explain that if people walk up to a nest often, cats and dogs may also find the nest and destroy it or the birds.

Pages 146–147–148–149

The sequence of pictures on these pages is self-explanatory. Have the children read them, tell the story in their own words, and answer the questions which are asked.

Old birds' nests may be studied at this time and compared with the robin's nest. If possible, study an actual robin's nest. The children may be curious about the source of the materials. The grasses are easily found by the birds. Fine roots are found at the edges of banks where sod is exposed. Strings are picked up along streets and highways where people throw them. Mud is taken from a nearby mud puddle.

A visit to see a nest with eggs in it is appropriate at this time. A few precautions are necessary, and it is helpful to have an extra adult along. The class should be kept well back from the nest, and the children taken closer two at a time for a quick peek at the nest and its contents. If the nest is high, and many birds' nests are, the children can be taken to within twenty feet or so to see the mother bird on the nest.

Pictures of birds' nests, eggs and nestlings may be put on the bulletin board.

Pages 150–151

Many birds are helpless when they hatch from the eggs, but there are many others that can move around and take some care of themselves. These two pages tell the story of the nesting of a duck, so that the young can be compared with those of the robin.

Sometimes it is possible to take children to a home where there are newly hatched ducks or fowls. Then the children may see for themselves the great difference in the young when compared with those of song birds.

Pages 152–153

The activities suggested on these pages need little elaboration. The germinal disc, referred to as the "little white spot," may not be on the upper side of the yolk when the egg is broken in the dish, but it will appear if the egg is turned carefully with a spoon, at the same time tipping the dish.

It is essential that the children recognize the hen as a bird if this activity is to have its greatest value. Many people do not think of hens as birds, so it may be well to call attention to the similarities in the shape of the eggs, the feathers, and the wings. Some pupils may object that chickens do not fly, but others may have seen chickens fly a little. The teacher may explain that wild chickens fly well.

The children may raise some questions regarding the origin of eggs. Explain that the egg forms inside the hen, the yolk first, then the white is added, and the shell is put on last. Have no hesitation about telling the children that the hen has an opening in her body and that she forces the egg out through this opening.

Pages 154–155

There is no need for greater detail in the early development of the chick than that given here. We want the children to know that the chicken grows from the tiny germinal disc inside the egg, that food is provided for its growth, and that warmth is necessary for development. Specific details of growth would probably have no meaning at this level.

The opening of the shell, on the other hand, is interesting to children. From the sequence of pictures the children can see that the chick picks a hole in the shell, enlarges the hole and extends it around the shell until the two halves fall apart. Have the children note that the newly-hatched chicken is feathered and can stand.

If it is possible to see some incubators and young chickens this is an opportune time to do so. If the trip was taken earlier, references can be made to it during the study of these pages.

Pages 156–157–158

These pages have been included to broaden the children's understanding of the places where birds lay eggs. It is not to be expected that the children memorize the information; rather they should realize that birds of different species may lay eggs in different kinds of places.

Pages 156–157 show—No. 1 a chipping sparrow, No. 2 a flicker, No. 3 a meadowlark, No. 4 an oriole, No. 5 a redwing, and No. 6 a kingfisher.

These pages may be enriched by studying collections of birds' nests, and by viewing pictures, slides, or moving pictures. Where different kinds of nests are visible near the school, trips should be taken to see them.

Summary Questions

1. Pages 156, 157, and 158 show six places where birds build nests. Some birds build no nest but lay their eggs on the ground. Some birds use bird houses as well as holes in trees. Chimney swifts build nests in chimneys or hollow trees. Some birds make nests on cliffs; others plaster mud nests under eaves of houses. A few use bird houses. Answers to this question will depend upon the experiences of the children.

2. The parts studied are the shell, the white, the yolk, the "white spot," and the air space.

3. The mother bird keeps her eggs warm by pressing them against her breast and by keeping rain off them with her feathers. The male of some species helps her.

4. Chickens, ducks, turkeys, and geese walk about almost as soon as they hatch; among the water birds most ducks, shore birds, and fowls such as pheasants, walk about soon after hatching.

5. The "song birds," such as sparrows, robins, and blackbirds, are nearly helpless when hatched.

6. First it makes a hole in the shell and then it makes the hole larger until it extends around the egg and the shell falls apart.

7. The mother bird lays the eggs.

Follow-up

The follow-up of this unit will probably last until the end of the school year. The children should continue watching the activities of birds. They may find new nests. They may discover that a bird house is inhabited. Pictures may be used to enrich observations in the field.

If possible, arrange for a trip to a poultry farm to see how domestic birds are cared for.

POSSIBLE LEARNINGS

Birds lay eggs in many different places.

Birds make many different kinds of nests.

Birds keep their eggs warm until the eggs hatch.

Some young birds are helpless when hatched, others can partly take care of themselves.

A baby bird develops from a small part of an egg.

Most of the egg serves as food for the baby bird as it develops inside the egg.

BIBLIOGRAPHY

Books

Birds and Their Nests. Olive Earle. George J. McLeod: Toronto, 1952. 60 pages.
Illustrated material on birds, their eggs, and nests.

Birds in Their Homes. Addison Webb. Blue Ribbon Books: Toronto, 1947. 66 pages.
The simple text and good illustrations will help much with the study of birds' nests, eggs, and care of their young.

Egg to Chick. Millicent Selsam. Progress: Toronto, 1946. 31 pages.
How a hen's egg is formed and how it develops.

First Book of Birds. Margaret Williamson. Ambassador Books: Toronto, 1951. 69 pages.
A simple text with diagrams and pictures answering questions on bird anatomy and bird life.

Robins in the Garden. Olive Earle. George J. McLeod: Toronto, 1953. 63 pages.
The story of a robin from nest building to flight.

Wonderful Egg. G. Warren Schloat. S. J. Reginald Saunders: Toronto, 1952. Unpaged.
Photographs and drawings plus a few lines of text designed to help children understand how an egg becomes a chicken.

Film

Robin Redbreast. Encyclopaedia Britannica Films. Ontario Department of Education: SN-64.
The story of a robin family from the time of nest building until the young robins can care for themselves.

Recordings

Canadian Bird Songs Album. Cornell University. Thomas Allen: Toronto.

American Bird Songs—Vol. 2. Comstock. Thomas Allen: Toronto.

Sounds of Nature—Vol. 1. Federation of Ontario Naturalists.

Songbirds of America. Soundbook. Thomas Allen: Toronto.

Wind

PURPOSE OF THE UNIT

References were made to the wind in *Exploring Science One* and in previous units of this text, but until now no attempts have been made to explain it as moving air. Instead, there has been a first-grade unit designed to show that air is a real substance, so that in later discussions pupils would have a better concept of air as something tangible. The work of that unit and references to air in other units, together with an increased maturity on the part of the children, makes this present study of wind more meaningful. We still cannot expect pupils to grasp completely the concept of air as a substance, but succeeding units dealing with fire, respiration, and airplanes will help strengthen and broaden the concept we want them to have.

Children will learn much through manipulation in the approach used here. They will develop increased co-ordination in the use of tools and common materials. They will use senses involved in muscular effort.

There are other important outcomes resulting from the activity approach—some of them so subtle that it is difficult to describe them—but outcomes easily apparent to understanding teachers. For example, in the making of pinwheels and wind vanes, there is satisfaction of a creative urge. The fact that all children are making pinwheels gives individuals a sense of belonging to the group—a feeling of security and happiness. And during periods of individualized work there is an opportunity for the teacher to work closely with individuals and to strengthen the bonds of sympathy and mutual understanding that are the mark of the successful classroom.

PREPARING FOR THE UNIT

The unit can be taught at any time of year but because many of the activities are more enjoyable when carried on outdoors, it is suggested that the unit be assigned to late spring or early fall.

No special preparation is necessary. If the unit is assigned to the spring, it is desirable to point out during the preceding months such things as will serve as a background for the unit. The children may be asked to describe what the wind is doing on very windy days. They may be asked to watch the school flag for indications that the wind is not blowing. They may watch for changes in wind direction.

Materials needed for the unit are those usually found in schools, with the possible exception of an electric fan which may be borrowed for a few days, and the feathers and soda straws.

List of Materials

- Pins
- Scissors
- Construction paper
- Tin cans
- Thermometers
- Electric fan
- Soda straws
- Feathers

TEACHING THE UNIT

A good time to open the unit is on a brisk windy day when there are many things being moved by the wind. The remainder of the unit is flexible and may be adjusted to the school programme and to such situations as arise.

Page 159

What things in the picture show that the wind is blowing? From what direction is the wind blowing? How can you tell? Is the wind doing anything useful in the picture?

Look outdoors. Is the wind blowing? How do you know? Which way is the wind blowing? Does it always blow in the same direction? Does it always blow as hard?

The children may be encouraged to make pictures of things they have seen the wind do.

Pages 160–161

These pages introduce the concept that wind is moving air. Note that the children are told this fact; it would be difficult to set up situations at this level in their experience that would allow them to do more than guess.

There are many more activities that can be used in addition to those suggested. Inflate a balloon and watch the air coming from its mouth move bits of thin paper or very light things. Swing a door rapidly to make a breeze. Direct a pupil to walk past an inflated balloon that is suspended by a thread; the breeze he makes will cause the balloon to move.

In each case, use the same explanation. Air is pushed from one place to another. As it moves it is wind.

Pages 162–163–164–165

These pages tell how to make a pinwheel and experiment with it. Other experiments should also be tried. Air escaping from a balloon will make the pinwheel turn. Air blown through a soda straw will make it turn. The pinwheel will turn outdoors on a windy day and will turn when held by an open window if there is a breeze through the window. A child may run with a pinwheel, or stand still and swing the pinwheel at arm's length. The pinwheel may be held on the front of a moving wagon or tricycle.

Sometimes children have pinwheels they have purchased. Let them bring these to school and exhibit them.

Toy windmills are common. Perhaps there is one near enough the school to be visited. Sometimes an older pupil who has made one will bring it to school and show it to the class.

Occasionally there are real windmills in the area, used either to pump water or generate electricity. If possible, take a trip to see one.

Page 166

This is a controlled experiment: one piece of cloth is held in the wind to see how fast it will dry, and the other piece, the control, is kept in still air to compare with the first one. Help the children understand why the second piece of cloth is used.

Page 167

Here is another controlled experiment. Discuss the experiment and ask them to guess what the outcome will be. Then try the experiment and let them check the outcome.

Pages 168–169

This simple wind vane can be made by every child. It is very sensitive and will detect weak currents of air.

Other wind vanes should be studied. Older pupils often make them and will exhibit them. Many communities have a large wind vane on a tower or steeple. Encourage the pupils to watch it.

The children may have developed a consciousness of compass directions by this time. If so, they may begin naming the winds. Remember that a wind is named for the direction from which it is blowing. Thus a wind coming from the north is called a north wind. The wind vane points in this direction.

If the pupils can determine wind directions by name, ask them to keep a record. Establish a wind vane near by and use it daily. If it is impossible to set up a wind vane, clouds and smoke can be used.

Pages 170–171

These are discussion pages. After studying them and discussing the information given, let the children tell of their experiences with the wind, what damage they have known it to do and what problems they have seen it produce. Let the children make pictures of hardships they have seen the wind cause. Pictures for the bulletin board can be used to supplement these pages.

Page 172

Wind assists many plants in distributing their seeds. This is the subject for an early fall unit in the third grade, but at this time children can be set looking for evidences of wind dispersal of seeds. The dandelion, of course, is a common subject. Other common plants that have their seeds dispersed by the wind are milkweeds, thistles, and poplar trees.

Summary Questions

1. Wind is moving air.
2. We use the wind to turn windmills and move boats. We use it to dry clothes and keep us cool.
3. The children may not have had much direct experience with wind damage, but pictures and readings will have told them about uprooted trees, damaged houses, and wrecked ships.
4. We can tell which way the wind blows by looking at a wind vane, by watching clouds and smoke move, and by throwing light things into the air to see which way they are carried.
5. The wind may uproot or break off plants and so harm them. The wind carries the seeds of many plants and so helps them.

Follow-up

The keeping of a wind direction record represents one type of follow-up. The teacher should also be alert for new situations that will make the pupils conscious of the wind—severe storms, trees blown down, kite flying, days of calm.

POSSIBLE LEARNINGS

Wind is moving air.
We can push air to start it moving.
Wind makes many things move.
Wind makes things dry faster.
Wind cools things.
We sometimes use the wind to help us.
Strong winds can do much damage.

BIBLIOGRAPHY

Books

Bonnie Bess, The Weathervane Horse. Alvin R. Tresselt. Ambassador Books: Toronto, 1949. 25 pages.

The story of a weathervane and the March winds.

Follow the Wind. Alvin R. Tresselt. Ambassador Books: Toronto, 1950. 26 pages.

An excellent picture book for use in nature classes.

Let's Find Out. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1946. 38 pages.

Air, heat, weather—a picture science book.

Film

Blow, Wind, Blow. Coronet. Ontario Department of Education: SG-56.

Wind as a helpful and destructive force. Designed to develop a background for the understanding of stories, poems, and songs about the wind.

List of Science Materials
(Class of Thirty Pupils)

QUANTITY	ITEM	REMARKS
2–15	hand lenses	low power; usable in every grade
2–15	insect nets or kitchen strainers	
2–15	household thermometers	usable in all following grades
2–4	large mirrors	6″ x 8″ or larger, preferably in frames
2–15	small mirrors	pocketbook size
2–15	dry cells	standard 1.5 volt; usable in fifth and sixth grades
2–15	lamp sockets	miniature sockets for flashlight bulbs
2–15	flashlight lamps	2.5 volt type for two-cell flashlights
2–6	electric bells	for 1.5 volt batteries
2–15	strong magnets	type used in first-grade unit "Magnets"
1 spool	insulated wire	No. 24, double cotton covered recommended
1	flashlight	
1	candle	
2–4	hens' eggs	
1 can	lubricating oil	type used for sewing machines and small motors
1	hammer	
1–15	scissors	
1–6	wire-cutting pliers	side-cutting type preferred
1	sharp knife	
1	yardstick	
1	hot-plate	or other source of heat
1	electric fan	if school has electricity
2–15	screw-top glass jars	pint size
	assorted glass jars	pint to gallon sizes
	assorted bottles	

QUANTITY	ITEM	REMARKS
2–4	ink bottles	
	tin cans	different types and sizes
	tin can lids	from friction-top cans
	large pans	
	kettle	for boiling an egg
	flower pots	assorted sizes
	wrapping paper	
1 sheet	white card	about 24″ x 30″
1 sheet	red card	about 24″ x 30″
	construction paper	assorted colours
	gummed labels	
	soda straws	
	cardboard cartons	large
	cheese boxes	cardboard, for process cheese, about 3″ x 3″ x 8″
	pins	common
	rubber bands	
	modelling clay	
	red ink	
	wire screening	scrap pieces about 18″ x 10″
	nails	assorted, including some about 4 inches long
	sand	
	spools	
	marbles	
2	boards	about 10″ wide and at least 4 feet long

General References for the Teacher

Audubon Nature Bulletins. Prepared and published by the National Audubon Society, New York. 4 pages each.

These bulletins contain background information on the things of our natural environment. List sent on request.

Cornell Rural School Leaflets. Prepared and published by Cornell University, Ithaca, New York.

These leaflets contain background information and suggestions for teaching almost every science topic.

Fieldbook of Natural History. E. Laurence Palmer. McGraw-Hill: Toronto, 1949. 664 pages.

Condensed information on a wide variety of plants, animals, rocks, and minerals.

Golden Treasury of Natural History. Bertha Parker. Musson: Toronto, 1952. 216 pages.

Interesting background information for the teacher.

Handbook of Nature Study. Anna B. Comstock. Thomas Allen: Toronto, 1939 ed. 937 pages.

Valuable for a general reference and teaching guide. An excellent source of information on common plants and animals.

Elementary School Science and How To Teach It. Glenn O. Blough and Albert J. Huggett. Macmillan of Canada: Toronto, 1951.

Among the main headings are: The Earth and the Universe; Living Things; Matter and Energy; Conservation of Our Resources; Fire and Prevention; The Behaviour and Habits of Animals.

Natural Science Through the Seasons. J. A. Partridge. Macmillan of Canada: Toronto, Revised Edition, 1955.

A practical and informative text for teachers of Grades I–VI.

Science for the Elementary-School Teacher. Gerald S. Craig. Ginn: Toronto, 1947. 551 pages.

Background information in a wide variety of science fields, together with scientific suggestions for teaching this material.

Making and Using Classroom Science Materials in the Elementary School. Glenn O. Blough and Marjorie H. Campbell. Macmillan of Canada: Toronto, 1954. 229 pages.

A practical book with descriptions of appropriate activities including photographs and drawings and carefully prepared lists of source material.

Conservation and Nature Activities. Audubon Society of Canada: Toronto.

Film Sources

Coronet Films. Sovereign Film Distributors Limited, 277 Victoria Street, Toronto.

Encyclopaedia Britannica Films. General Films Limited, 18 Breadalbane Street, Toronto.

Federation of Ontario Naturalists, 187 Highbourne Road, Toronto.

Gateway Productions Incorporated. Canadian Film Institute, 142 Sparks Street, Ottawa.

Jam Handy. General Films Limited, 18 Breadalbane Street, Toronto.

Ontario Department of Education, Visual Education Branch, 244 College Street, Toronto.

Young America Films. General Films Limited, 18 Breadalbane Street, Toronto.

Publishers' Addresses

Thomas Allen Limited, 266 King Street West, Toronto.

Ambassador Books Limited, 1149 King Street West, Toronto.

Audubon Society of Canada, 181 Jarvis Street, Toronto.

Blue Ribbon Books, 105 Bond Street, Toronto.

Brett-Macmillan Limited, 25 Hollinger Road, Toronto.

Clarke, Irwin and Company Limited, 103 St. Clair Avenue West, Toronto.

The Copp Clark Publishing Company Limited, 517 Wellington Street West, Toronto.

Doubleday Publishers, 105 Bond Street, Toronto.

W. J. Gage and Company Limited, 82 Spadina Avenue, Toronto.

Ginn and Company, 1331 Yonge Street, Toronto.

The Macmillan Company of Canada Limited, 70 Bond Street, Toronto.

McGraw-Hill Company of Canada Limited, 253 Spadina Road, Toronto.

George J. McLeod Limited, 73 Bathurst Street, Toronto.

Musson Book Company Limited, 103-107 Vanderhoof Avenue, Toronto.

National Audubon Society, 1000 Fifth Avenue, New York.

Nelson, Foster & Scott Limited, 87 John Street, Toronto.

Progress Publishing Company, 740 Bathurst Street, Toronto.

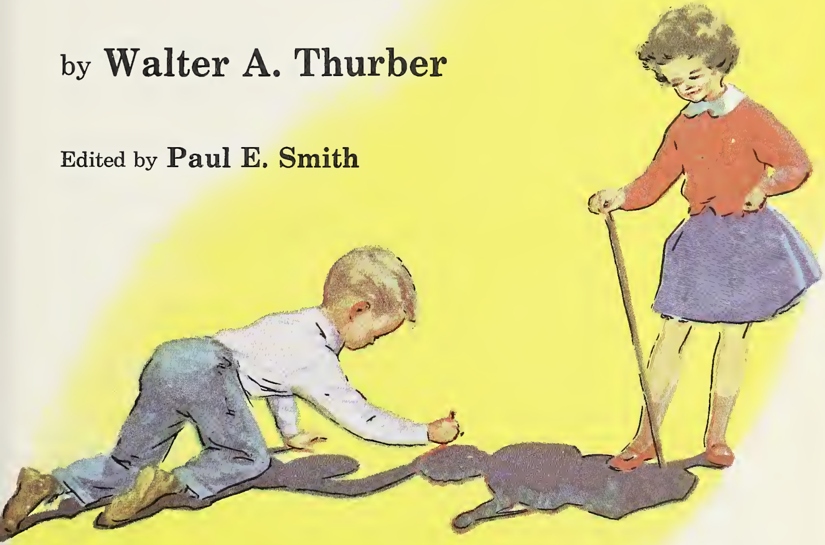
S. J. Reginald Saunders & Company Limited, 266 King Street West, Toronto.

EXPLORING SCIENCE

Two

by **Walter A. Thurber**

Edited by **Paul E. Smith**



THE MACMILLAN COMPANY
OF CANADA LIMITED
TORONTO

EXPLORING SCIENCE SERIES

One · Two · Three · Four · Five · Six

READING
CONSULTANT

Linda C. Smith

Revised Canadian Edition

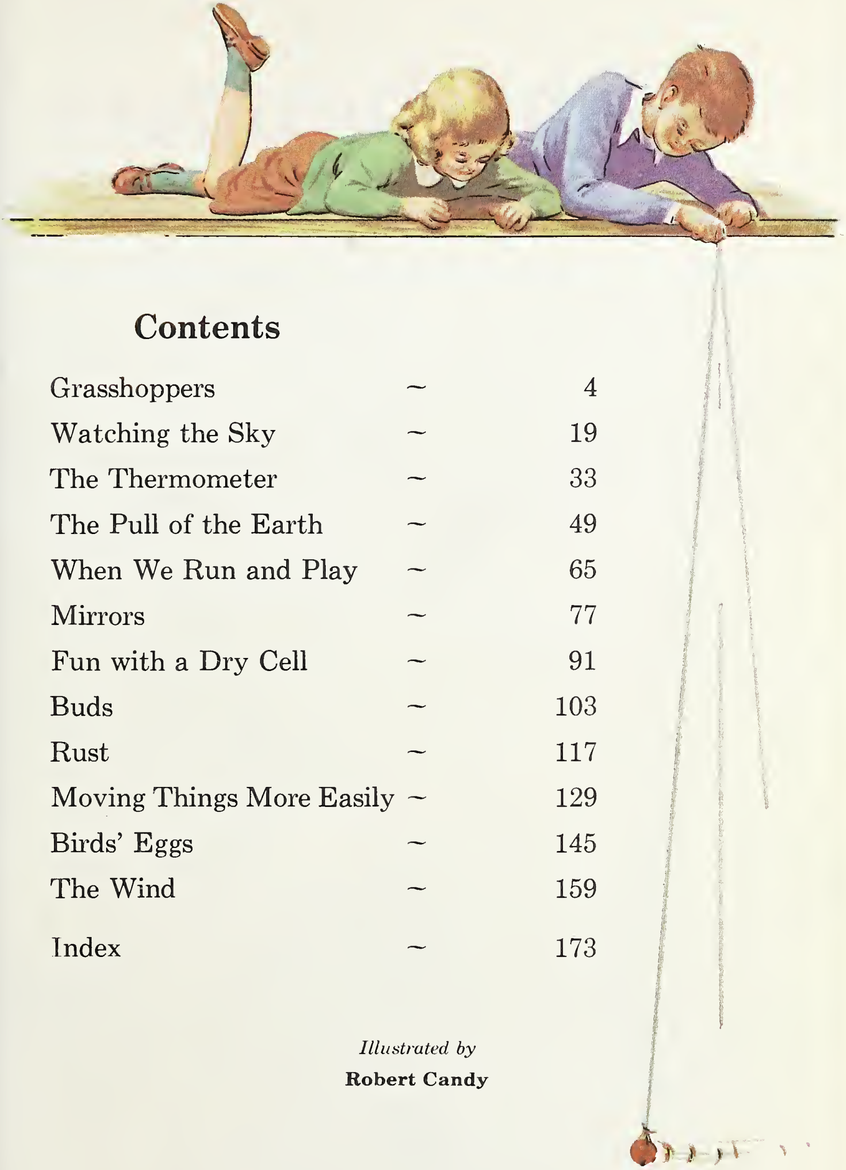
Copyright, 1957

THE MACMILLAN COMPANY
OF CANADA LIMITED

Printed in Canada

Originally published by
ALLYN AND BACON, INC.

Due acknowledgment is made to H. A. MacGREGOR, M.S. (Cornell), Ed.D. (Oregon State), Faculty of Education, University of Alberta, Edmonton, for his advice in the editing of the Canadian edition.



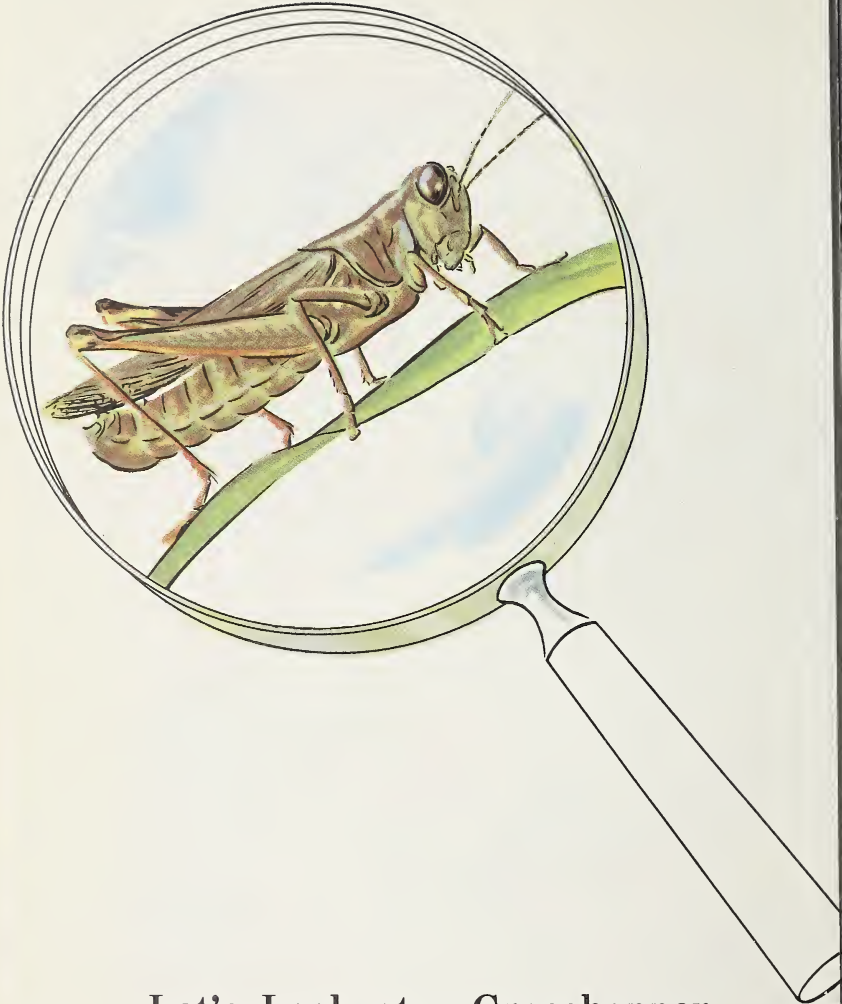
Contents

Grasshoppers ~ 4
Watching the Sky ~ 19
The Thermometer ~ 33
The Pull of the Earth ~ 49
When We Run and Play ~ 65
Mirrors ~ 77
Fun with a Dry Cell ~ 91
Buds ~ 103
Rust ~ 117
Moving Things More Easily ~ 129
Birds' Eggs ~ 145
The Wind ~ 159

Index ~ 173

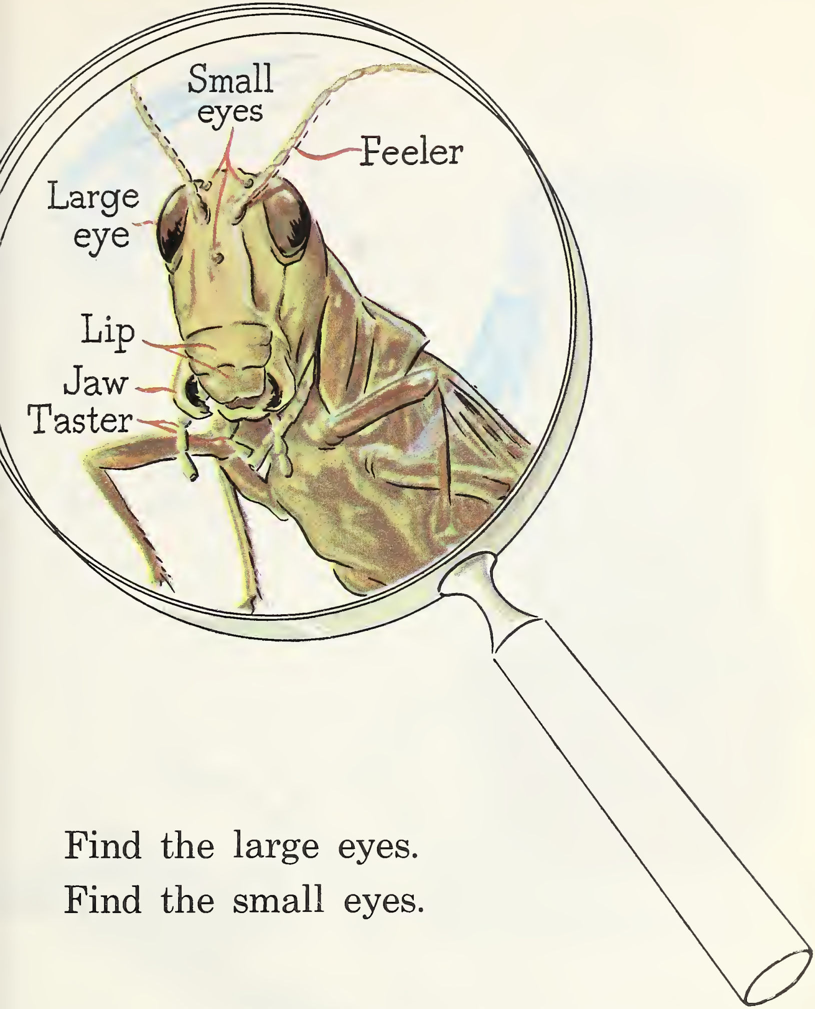
Illustrated by
Robert Candy

Grasshoppers



Let's Look at a Grasshopper

How many legs has a grasshopper?

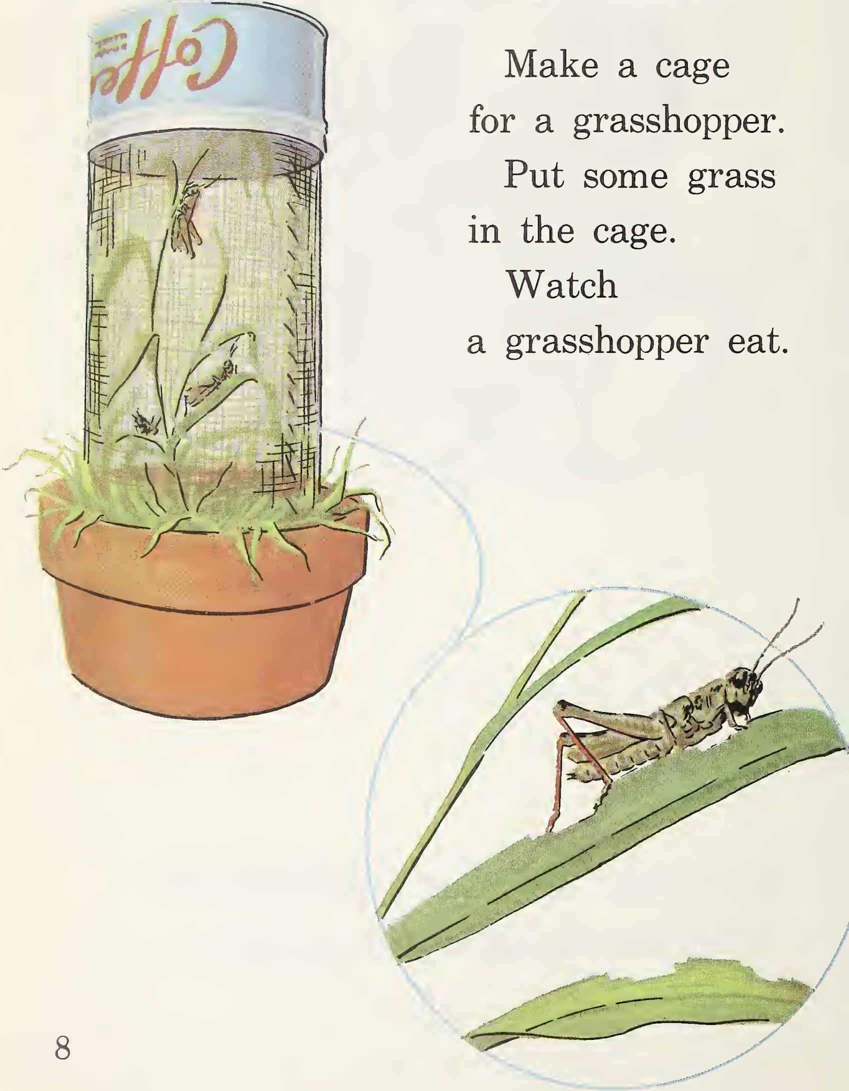


Find the large eyes.
Find the small eyes.

How many eyes has a grasshopper?
What other parts can you find?

Grasshoppers Eat Plants

Make a cage
for a grasshopper.
Put some grass
in the cage.
Watch
a grasshopper eat.

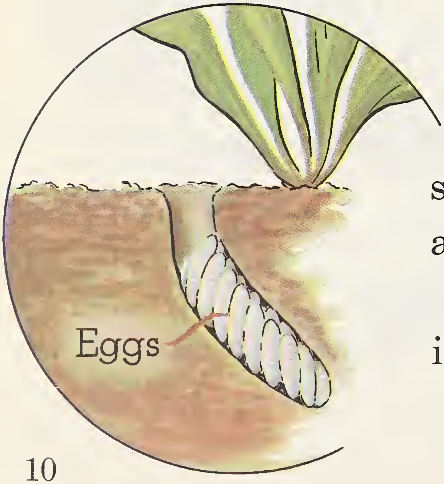


Sometimes there are
many grasshoppers.
Then they harm our gardens.

Grasshoppers Lay Eggs

Grasshoppers lay their eggs in the fall.

They lay their eggs in the ground.

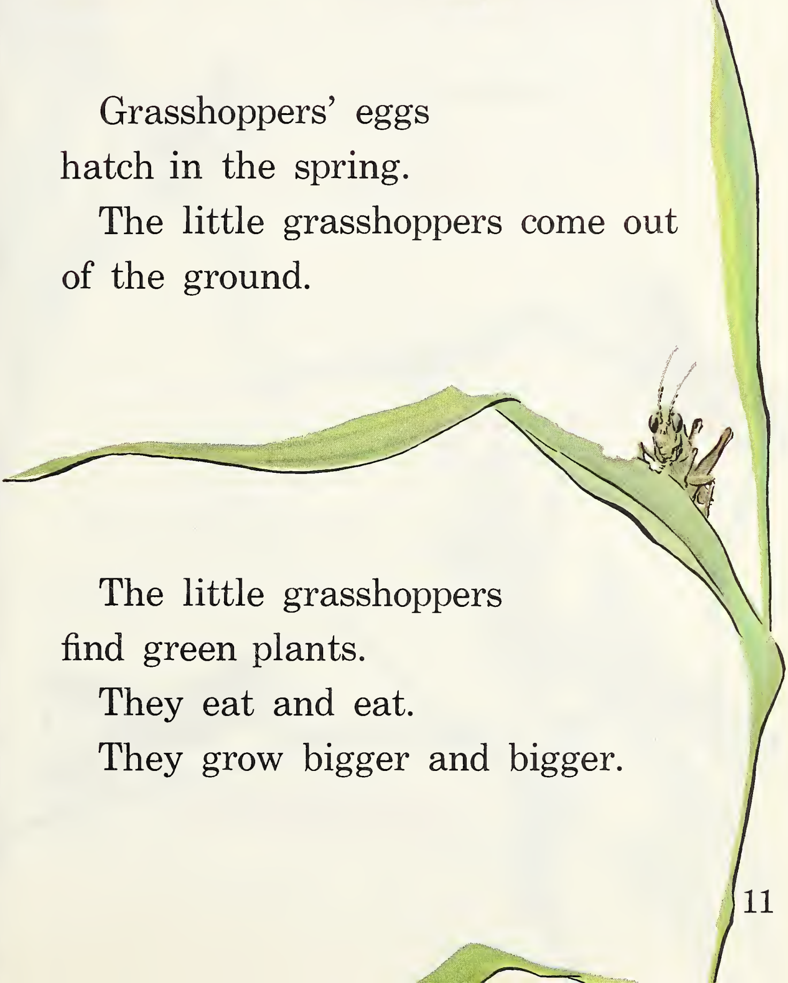


The eggs stay in the ground all winter.

The eggs hatch in the spring.

Grasshoppers' eggs
hatch in the spring.

The little grasshoppers come out of the ground.



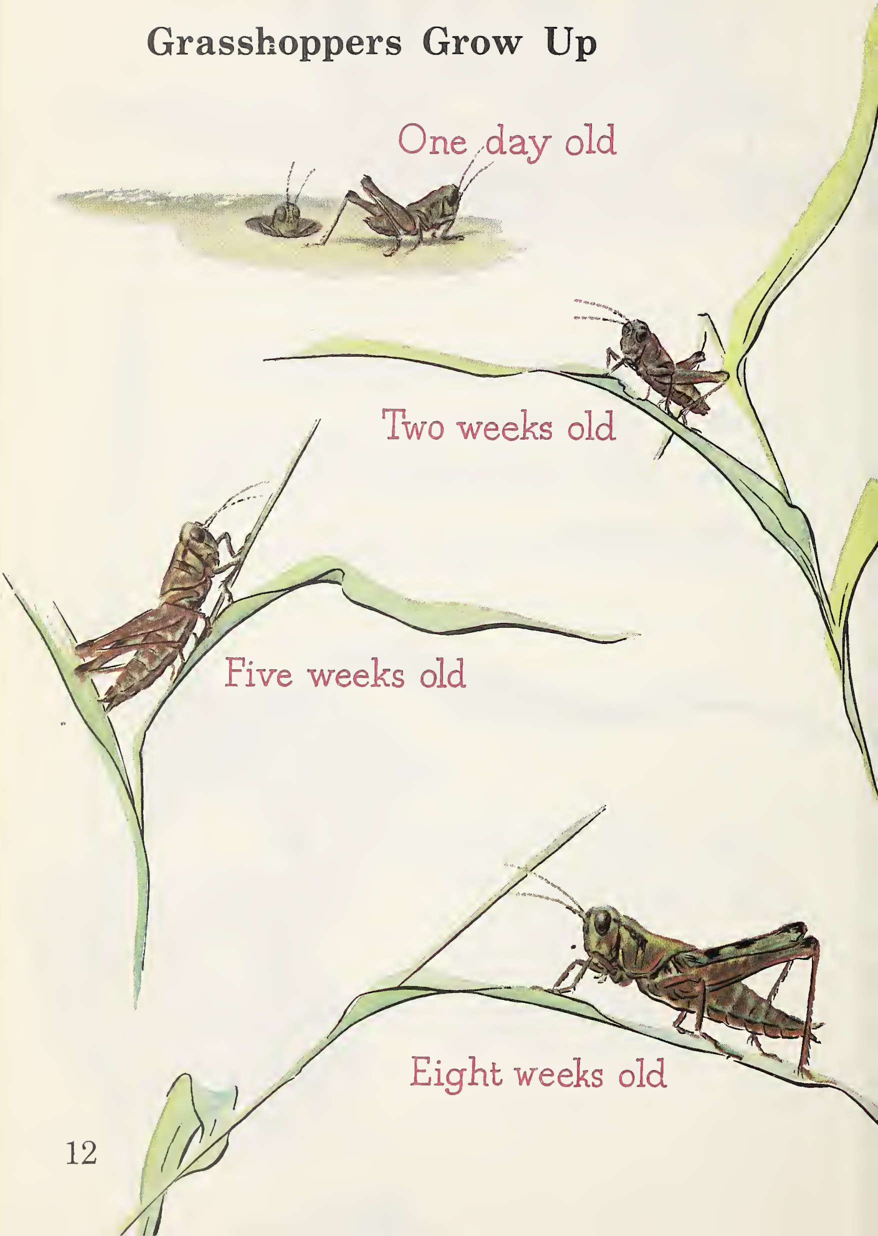
The little grasshoppers
find green plants.

They eat and eat.

They grow bigger and bigger.

OF ALBERTA

Grasshoppers Grow Up



A grasshopper eats and grows bigger.

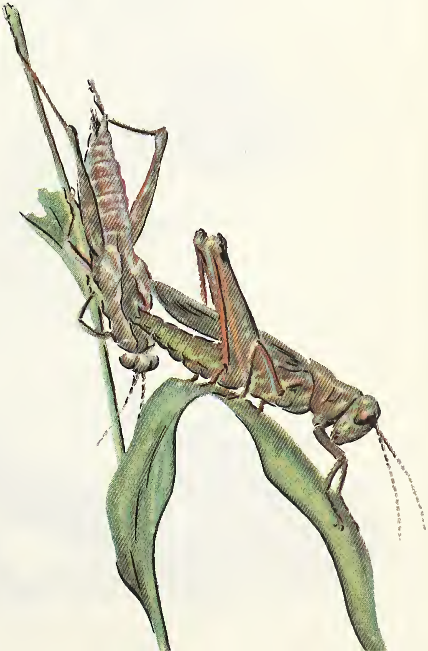
But its skin does not grow bigger.

A new skin grows under the old skin.

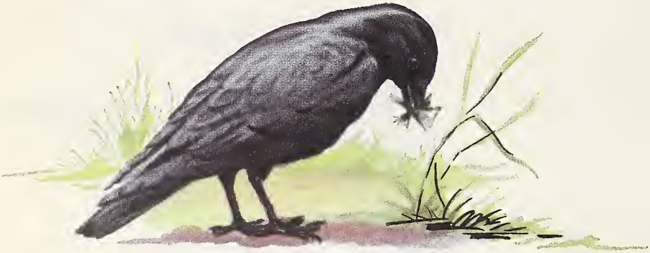
Then the old skin breaks open.

The grasshopper crawls out of its old skin.

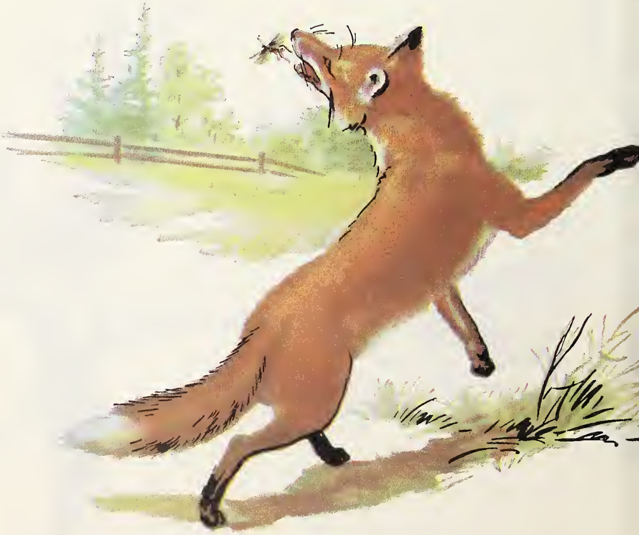
The new skin is bigger than the old skin.



Many Animals Eat Grasshoppers



Both of these animals
eat grasshoppers.
What are these animals?



These animals
eat grasshoppers too.
How many of these
animals do you know?

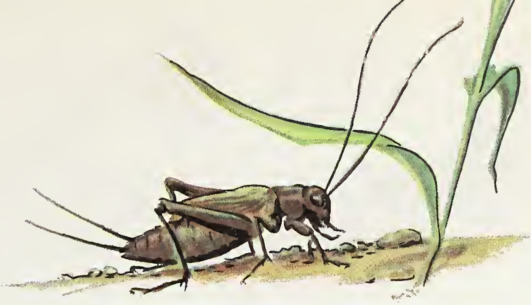
1

3

5

Something to Find Out

How far can a grasshopper jump?
How high can a grasshopper jump?



Crickets

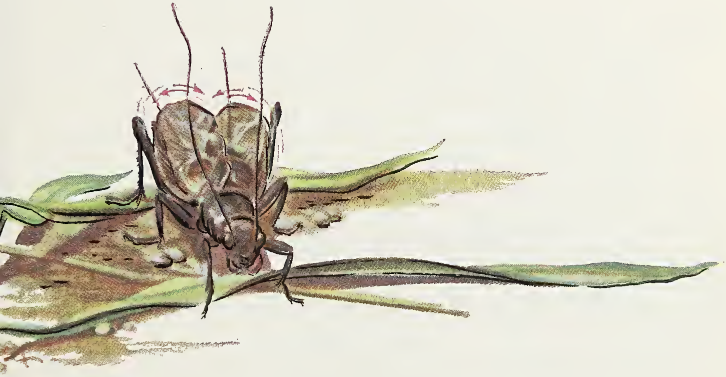
Crickets are like grasshoppers in some ways.

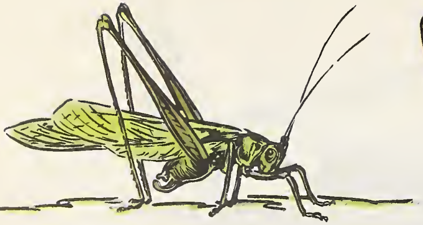
How are crickets like grasshoppers?

Some crickets make sounds.

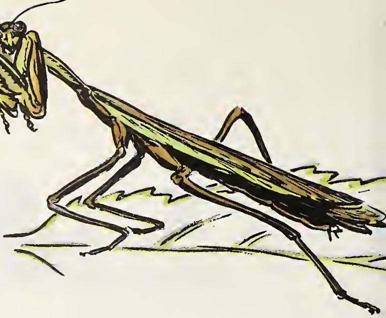
They make sounds with their wings.

Some grasshoppers make sounds too.





Katydid



Praying Mantis

Here are two more insects that are something like grasshoppers.

1. How do grasshoppers move?
2. How many legs do grasshoppers have?
3. How many eyes do grasshoppers have?
4. What do grasshoppers eat?
5. What animals eat grasshoppers?
6. Where do grasshoppers lay eggs?
7. How do grasshoppers grow?
8. How do they harm gardens?

Watching the Sky

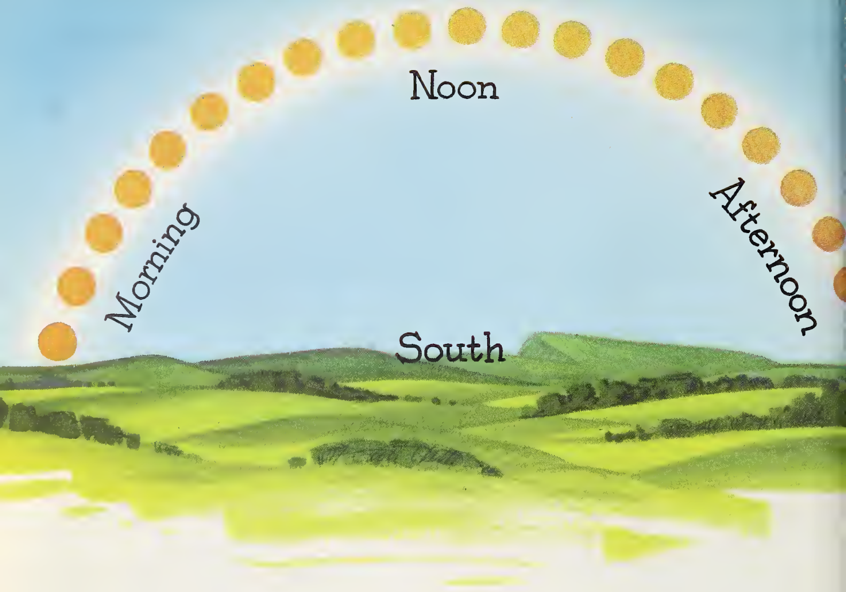
The Sun

Did you see the sun this morning?
In what part of the sky was it?

Watch the sun today.
Where is it at noon?

Look for the sun in the afternoon.

Which way does it seem to move across the sky?

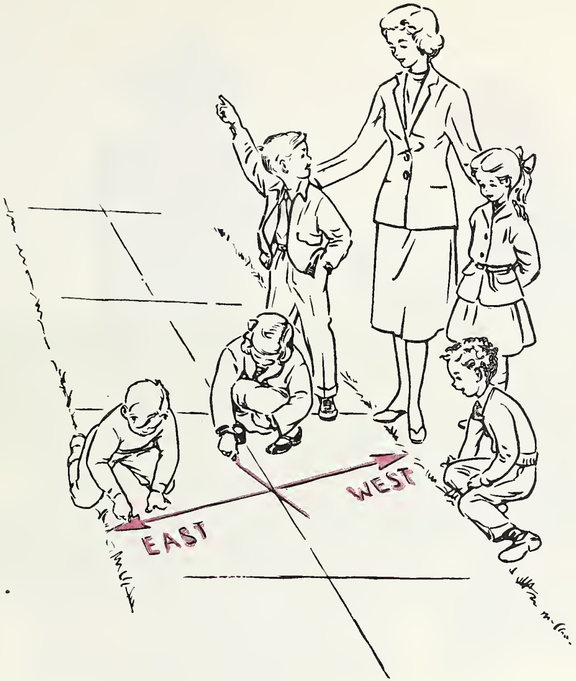


East and West

The sun appears in the east.
It seems to move across the sky all day.
Then it disappears in the west.

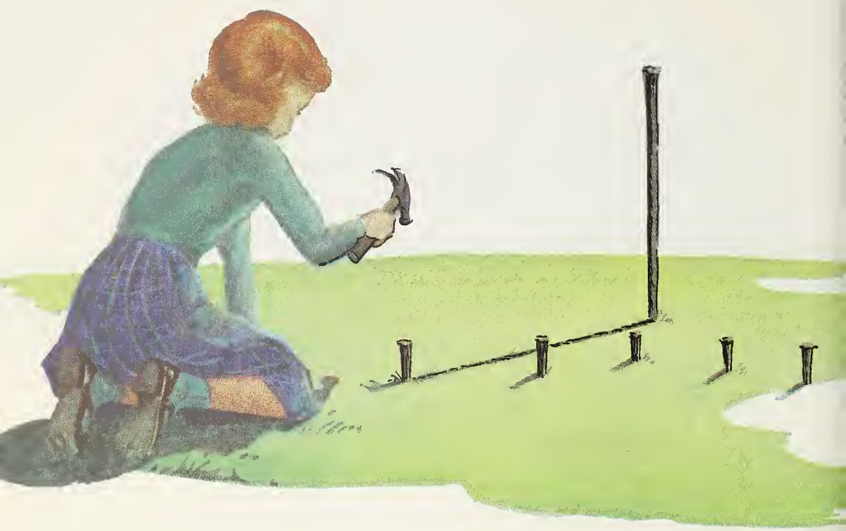
Point to the sun in the morning to find east.

Point to the sun in the afternoon to find west.



Find east and west at school.
Put marks on the ground
to show east and west.

Find east and west at home.
Put marks on the ground
to show east and west.

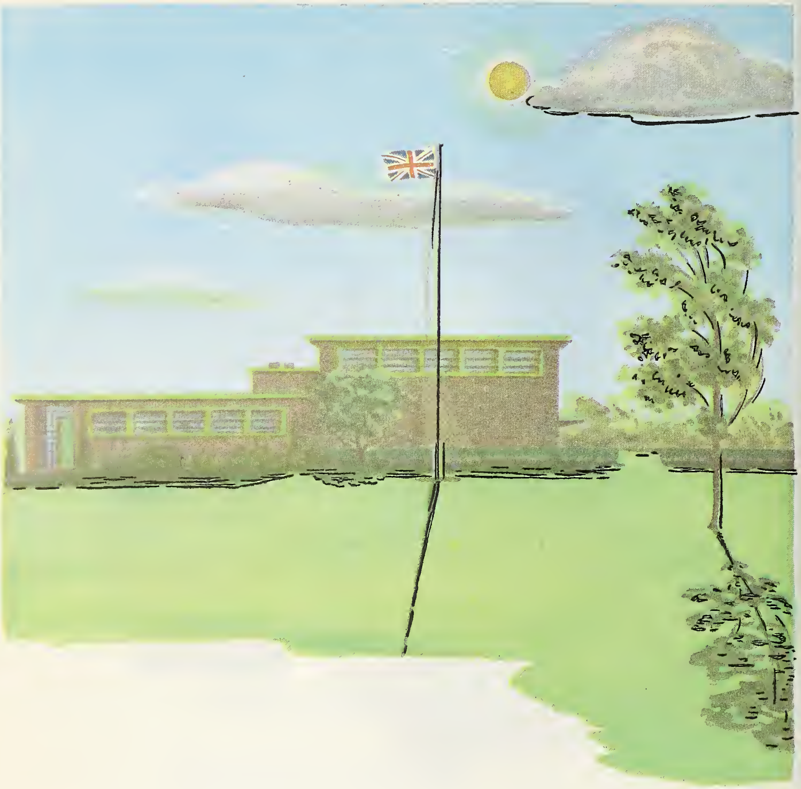


The Sun's Shadows

Watch a shadow
made by the sun.
Does it seem to move?

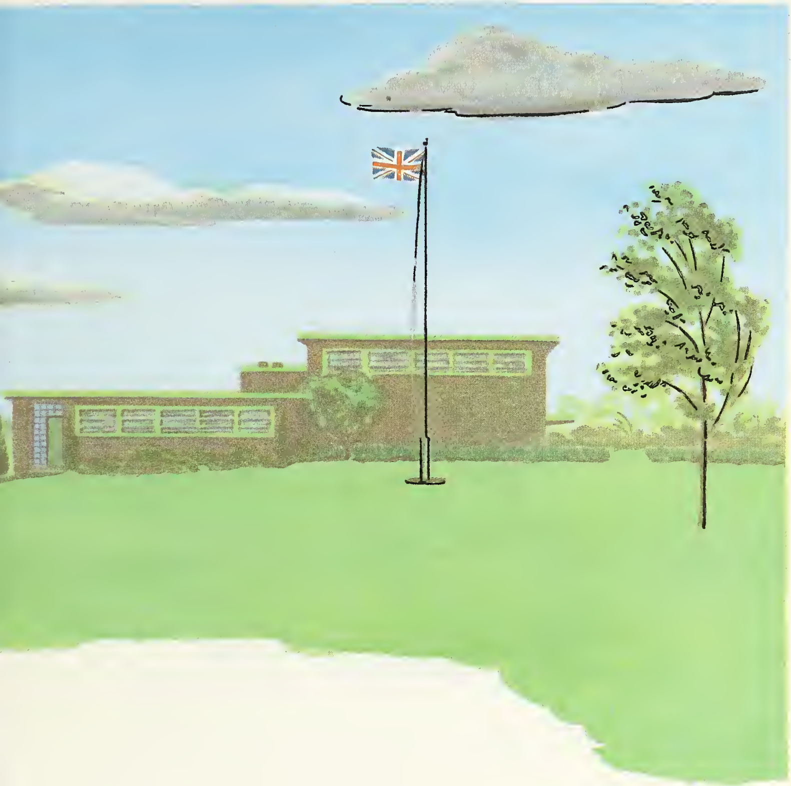
Mark the end of a shadow.
Mark it several times
during the day.
Does it move?

Draw someone's shadow
in the morning.
Draw it again at noon.
Are the shadows the same?



Clouds in the Sky

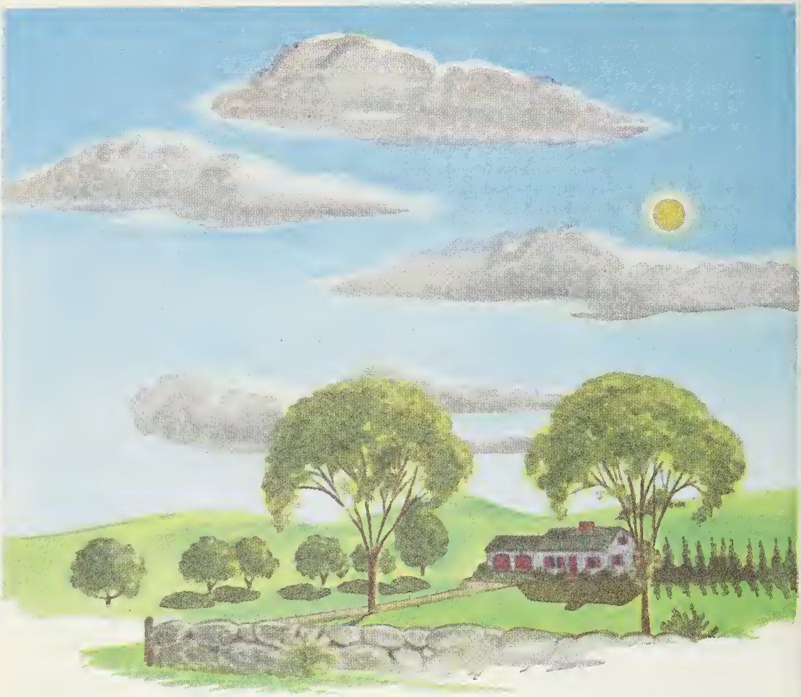
Watch some clouds.
Do they move?
Can you guess why they move?
Look at the next picture.



What has happened?
Where is the sun?

Why are there no shadows?

What do you think
will happen next?

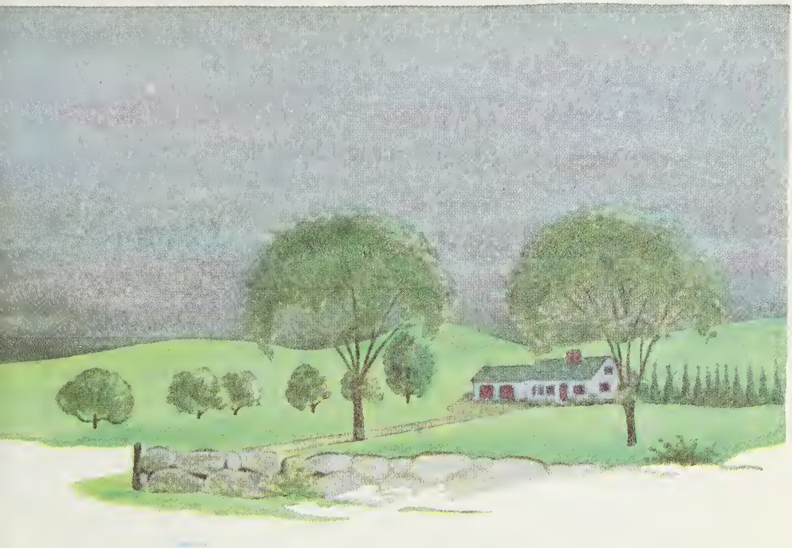


Sometimes clouds look like this.

Have you ever seen clouds like this?

Watch the sky for clouds.

Draw pictures of their shapes.

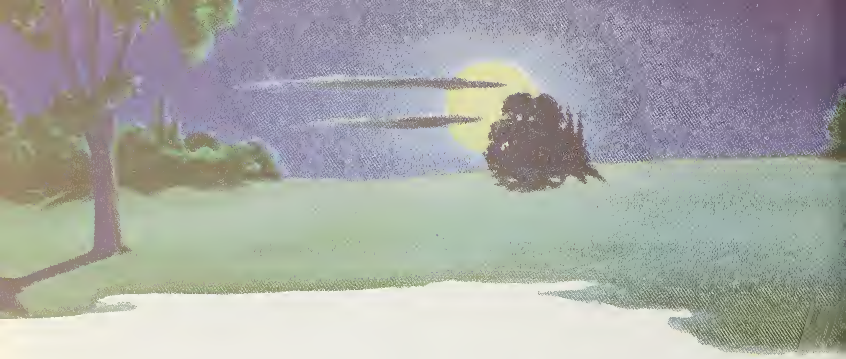


Sometimes clouds look like this.
Why are there no shadows?

What may happen
when the sky is like this?

Does it ever rain
when there are no clouds?

Does it always rain
if there are clouds?



The Sky at Night

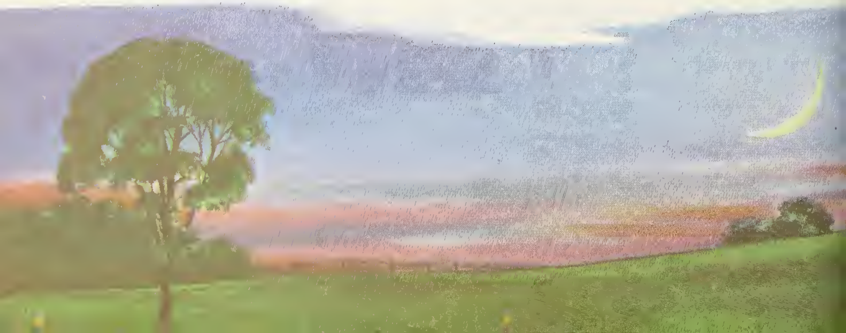
Have you ever seen the moon?

What shape did it have
when you saw it?

Sometimes the moon
looks like it does in these pictures.

Have you ever seen the moon
with another shape?

Draw pictures of the moon
as you have seen it.



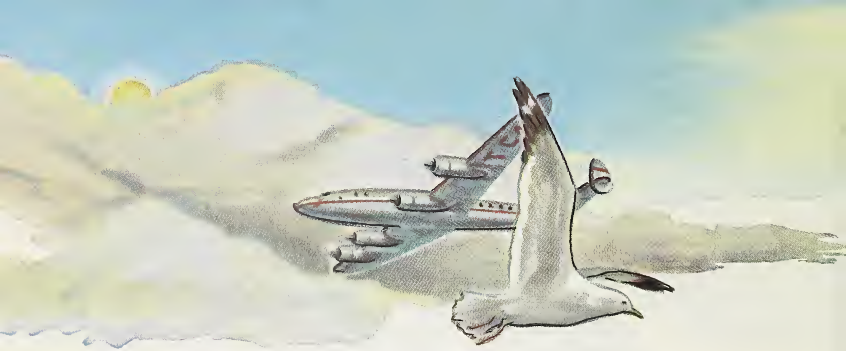
Watch the moon at night.

Does it move as the sun moves?

Have you ever seen the moon in the daytime?

Does it move in the daytime?

What else can you see in the sky at night?

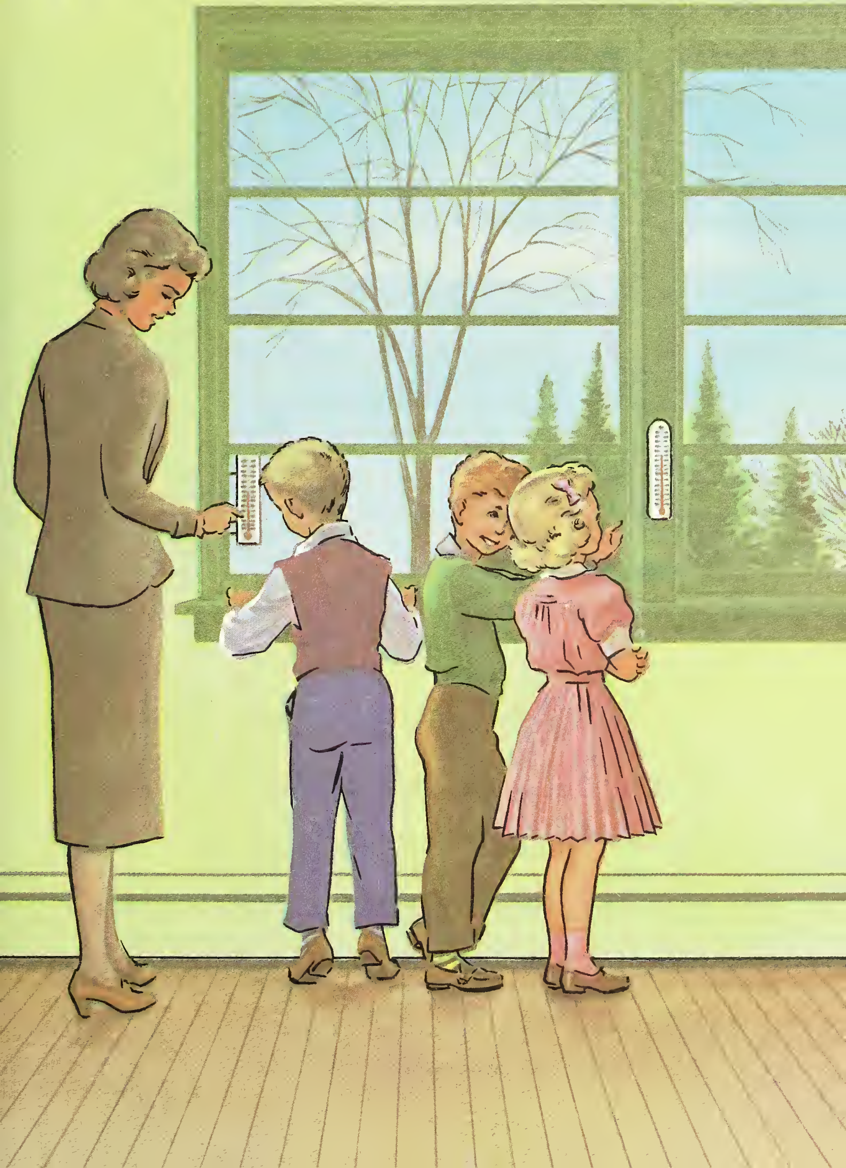


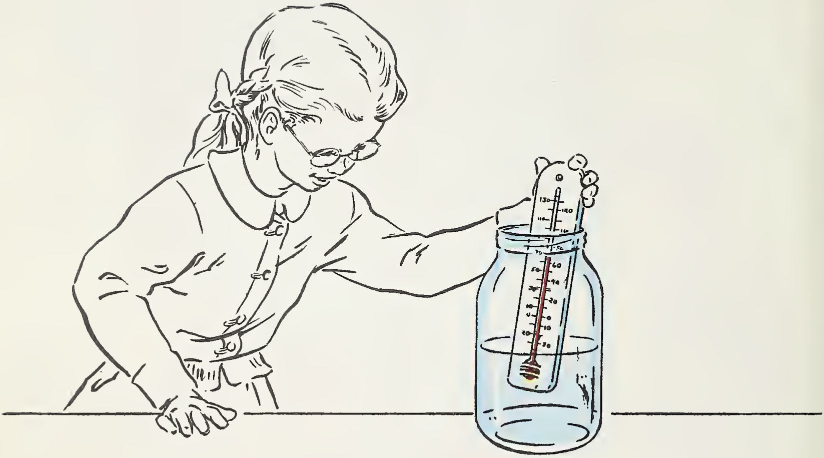
Which of these things
is nearest the earth?
Which of these things
is farthest from the earth?

---

1. What can we see in the sky?
2. When do we see the sun?
3. When do we not see the sun?
4. Where does the sun come up?
5. Where does the sun go down?
6. How do shadows
made by the sun change?
7. What makes the clouds move?
8. What shapes of the moon
have you seen?

he Thermometer

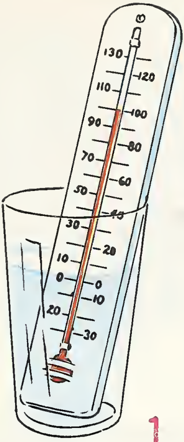




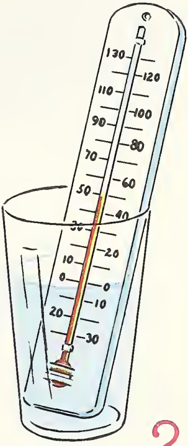
What a Thermometer Does

Put a thermometer in warm water.
What happens?

Put the thermometer in cold water.
What happens?



1

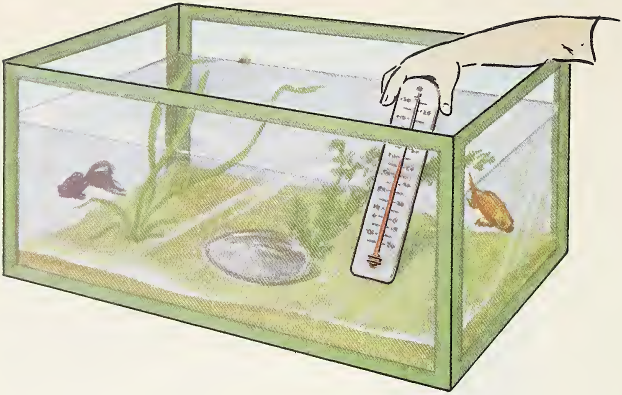


2

Which glass has warm water in it?
Which glass has cold water in it?

What is the temperature of the warm water?

What is the temperature of the cold water?

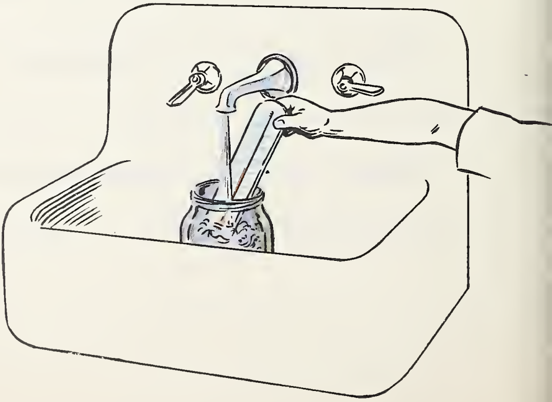


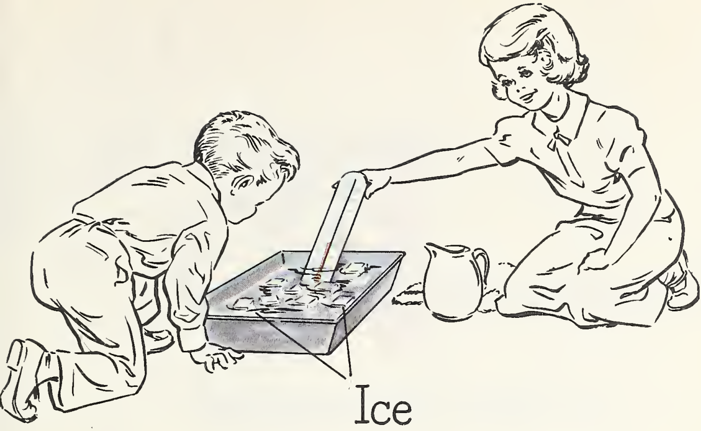
Finding Temperatures Indoors

Find the temperature
of your aquarium.

Is the water as warm as the air?

Find the temperature
of cold water from the faucet.



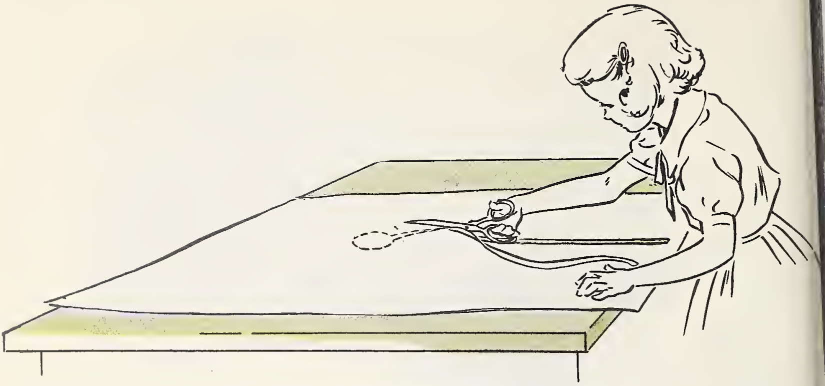


Find the temperature of ice water.

Find the temperature
in a boy's pocket.

What is the warmest temperature
you found?

What is the coldest temperature
you found?



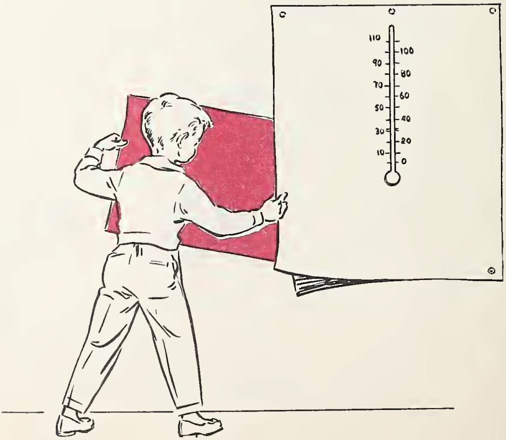
A Play Thermometer

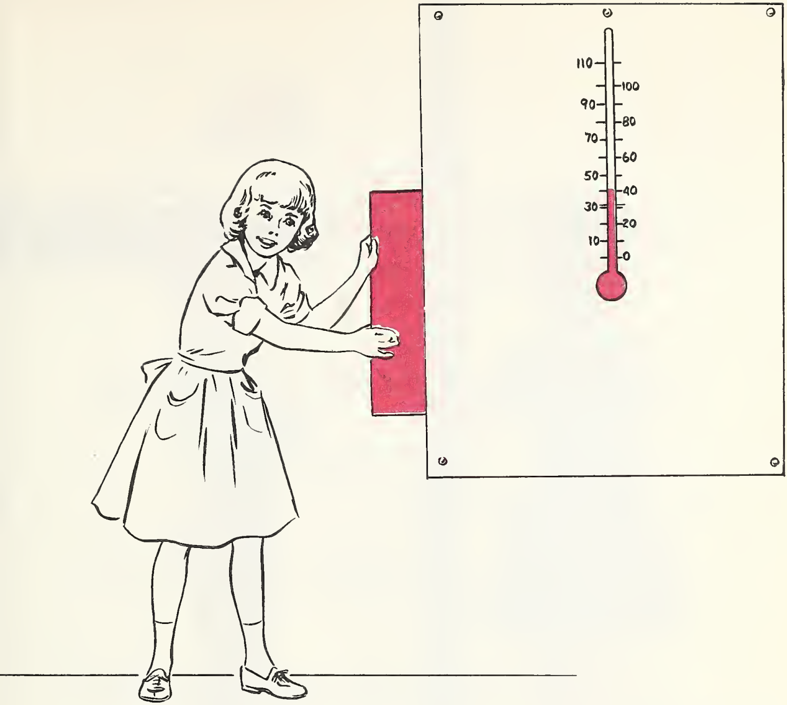
Draw a large thermometer.

Cut out the thermometer.

Put the thermometer
on your bulletin board.

Hold a sheet of red paper
behind it.





Your thermometer
will look like this.

Move the red paper up and down.

Each day read a real thermometer.

Make your play thermometer
read the same.

Finding Temperature Outdoors

Find the temperature
of water outdoors.

Find the temperature of the soil.

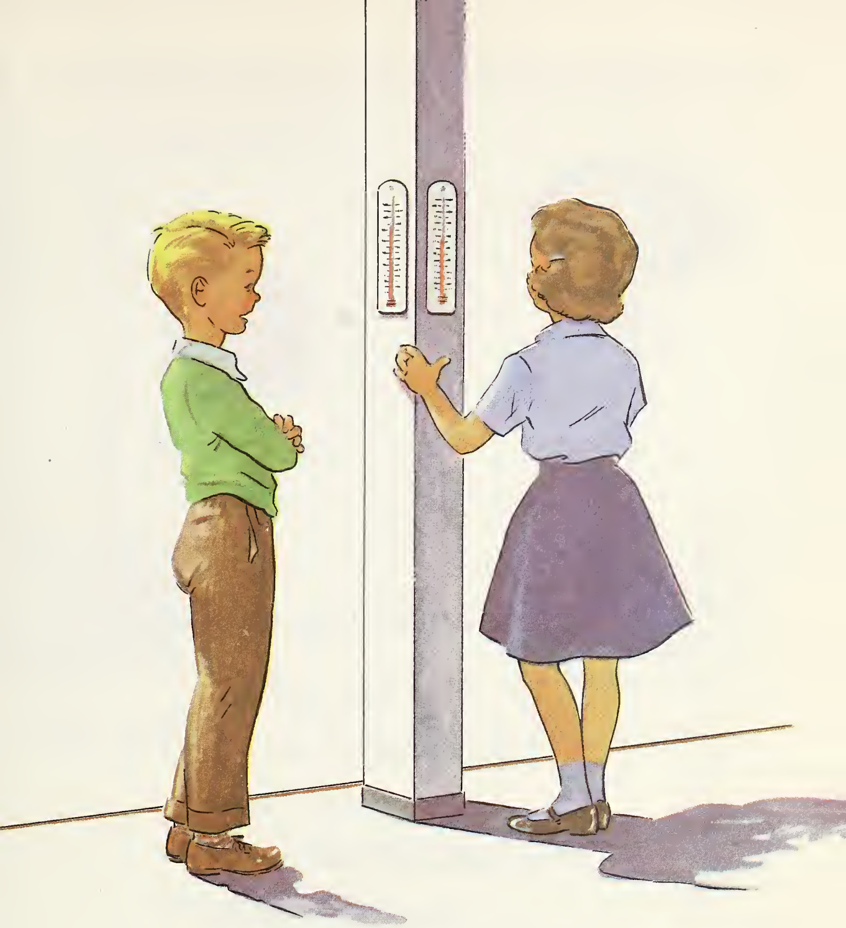
Lift up a stone.

Put a thermometer under the stone.

What is the temperature
under the stone?

What is the warmest temperature
you found?

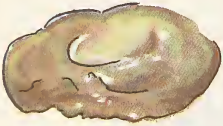
What is the coldest temperature
you found?



Find the temperature outdoors in sunshine.

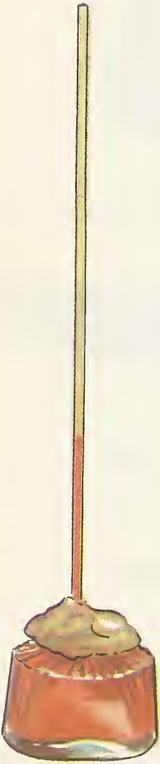
Find the temperature outdoors in shade.

Soda straw



Clay

Ink bottle



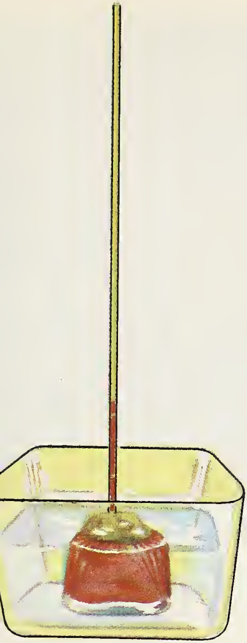
Making a Thermometer

Fill the bottle
with red ink.

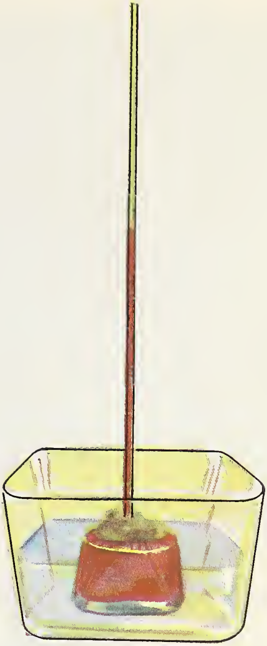
Put some clay
around the straw.

Push the straw
into the bottle.

Be sure the clay
is tight.



Cold water



Warm water

Put your thermometer
in cold water.

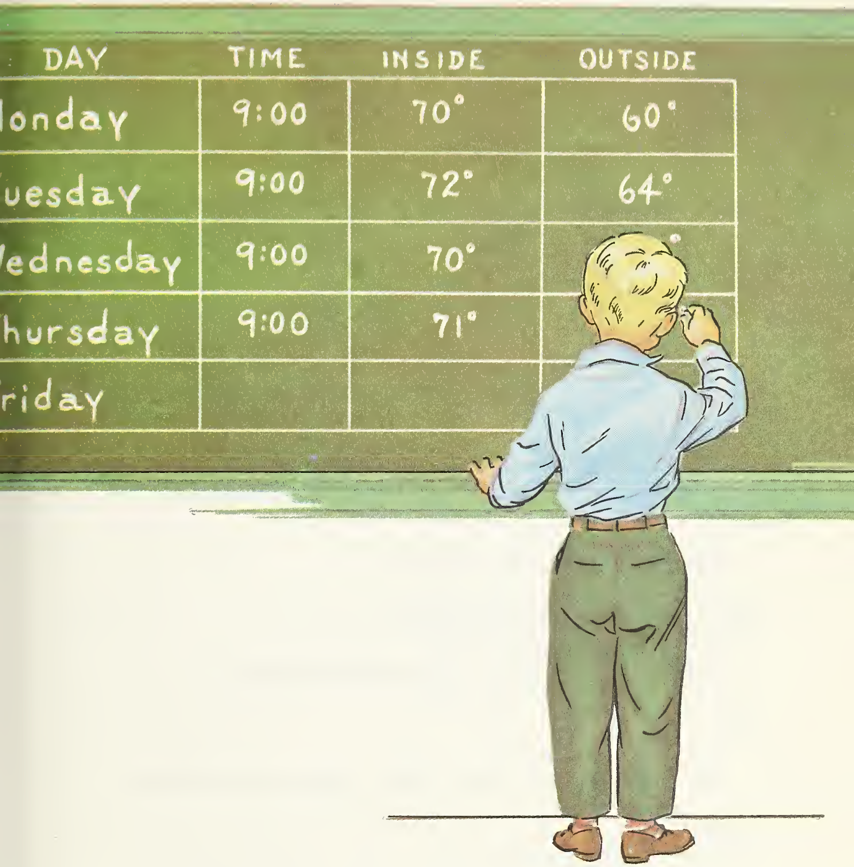
Put your thermometer
in warm water.

What happens?

Can you tell why?

Keeping a Temperature Record

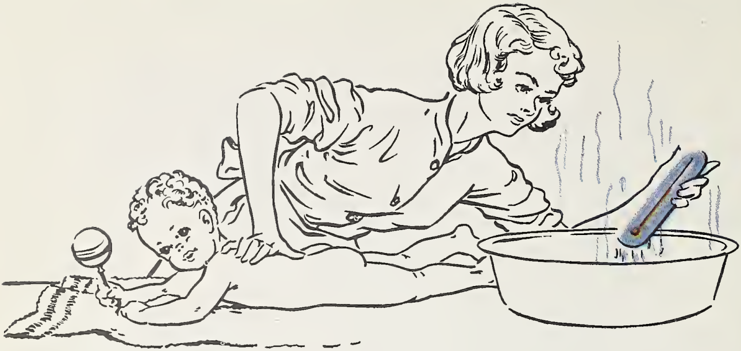
Find the temperature
outside the window.
Find the temperature
inside the window.
Which is higher?



DAY	TIME	INSIDE	OUTSIDE
onday	9:00	70°	60°
uesday	9:00	72°	64°
ednesday	9:00	70°	°
hursday	9:00	71°	
riday			

Keep a temperature record on the blackboard.

Keep the record every day.

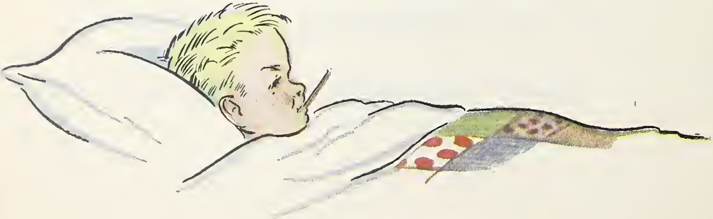


How We Use Thermometers

Here are two ways
we use thermometers.

Tell what the thermometers
are used for.

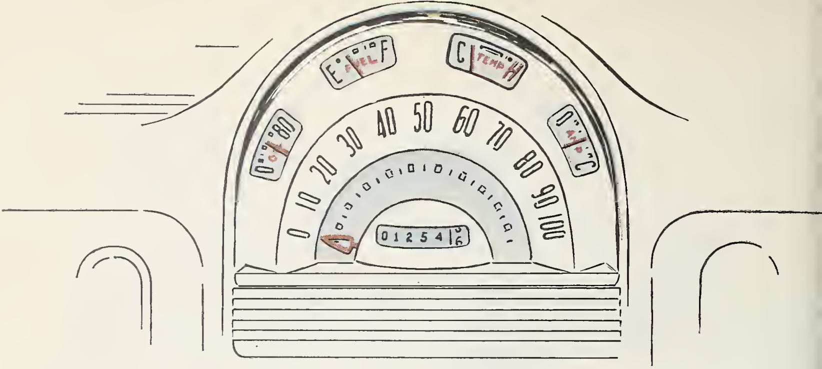
Why do we use the thermometers
this way?



Sometimes we use thermometers when we cook.

Can you tell why?

Do you know of some other ways we use thermometers?



Does your car have a thermometer?
Do you know what it is used for?
Ask your father why it is used.

---

1. What is a thermometer for?
2. How does a thermometer work?
3. What is the usual temperature of your classroom?
4. What is the temperature of ice water?
5. How are thermometers used?
6. Is the temperature in the sunshine higher or lower than in the shade?

The Pull of the Earth

Why Things Fall

The boy is going to let go of the ball.

What will happen?

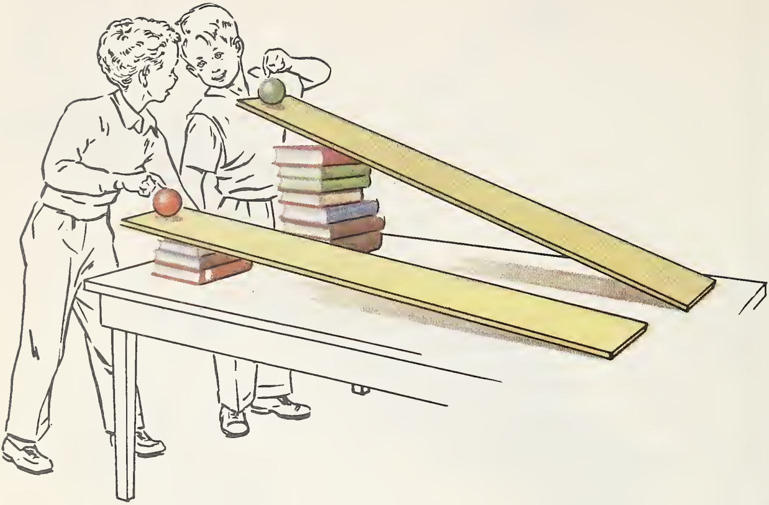
The earth pulls on the ball.

The earth makes the ball fall.

Throw a ball into the air.

What happens to the ball?

Tell why the ball does this?



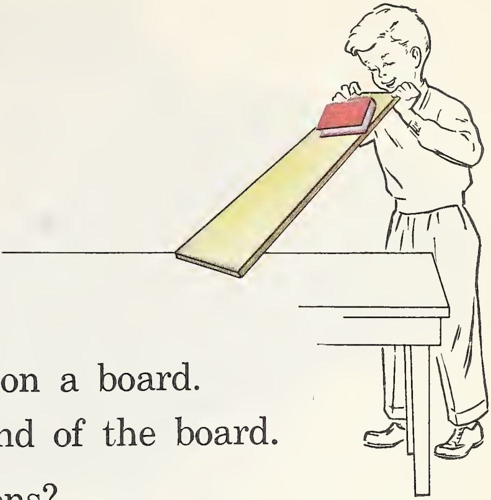
Why Things Move Downhill

These balls cannot fall straight down.

The pull of the earth makes them roll.

Which one will roll faster?

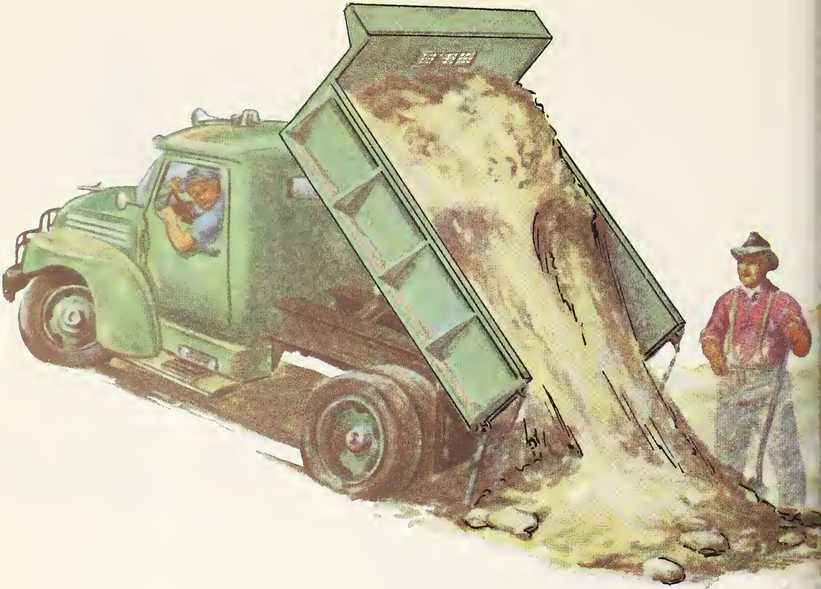
What are some other things that roll downhill?



Put a book on a board.
Raise one end of the board.

What happens?
Can you tell why?

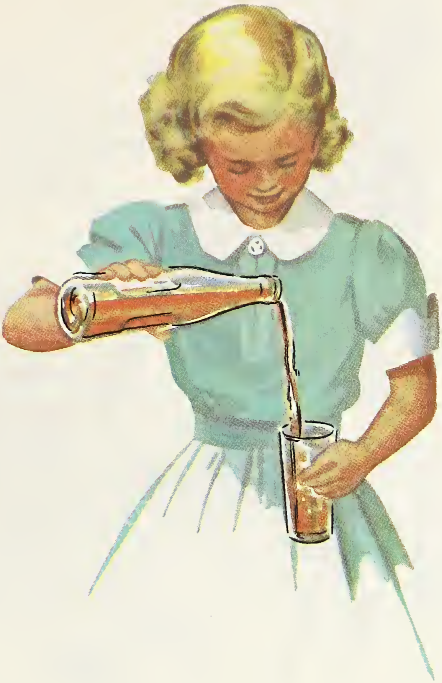
What are some other things that slide downhill?



Using the Pull of the Earth

What is happening in the picture?
Tell why the soil leaves the truck.

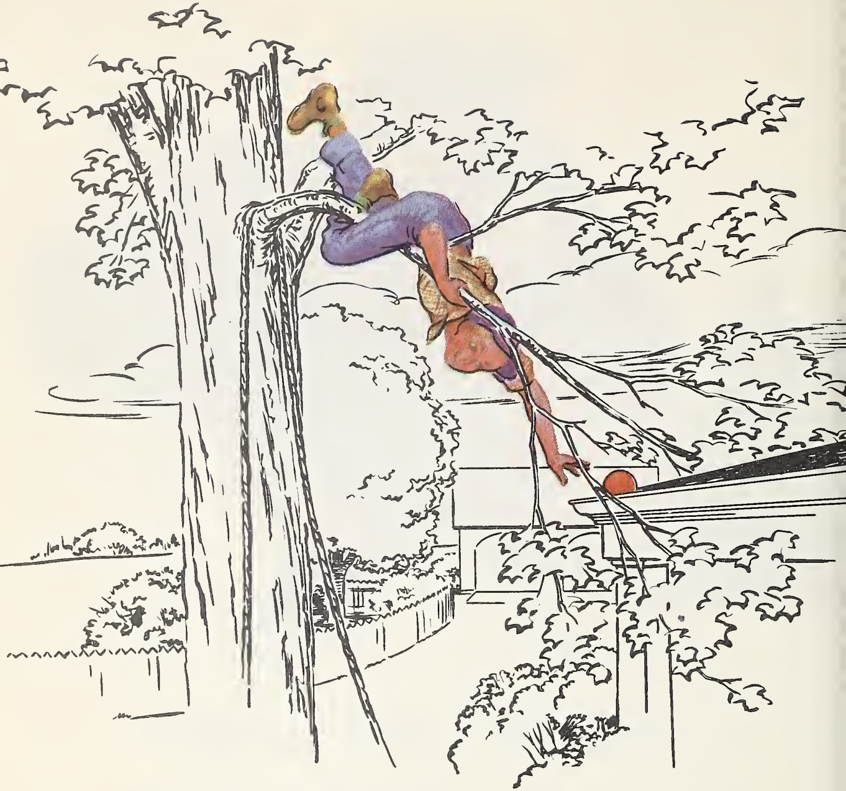
How is the earth's pull
used on the farm?
How is the earth's pull
used in the city?



What is the girl doing?

How is she using
the pull of the earth?

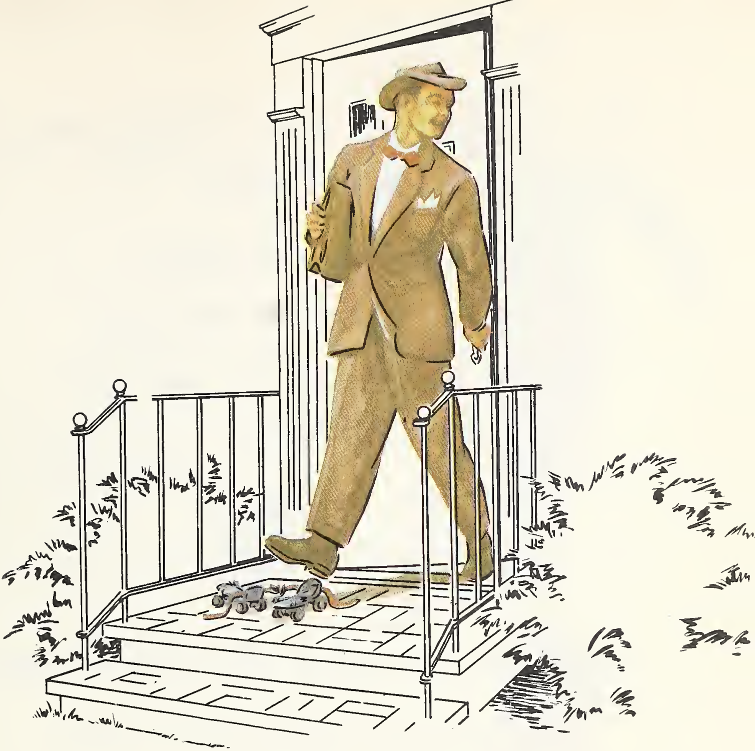
How do we use the earth's pull
at home?



The Pull of the Earth May Hurt Us

What is the boy doing?
What may happen?

What would be a better thing for him to do?



What may happen here?

How else may the pull of the earth hurt us?

List ways to keep from being hurt by the pull of the earth.

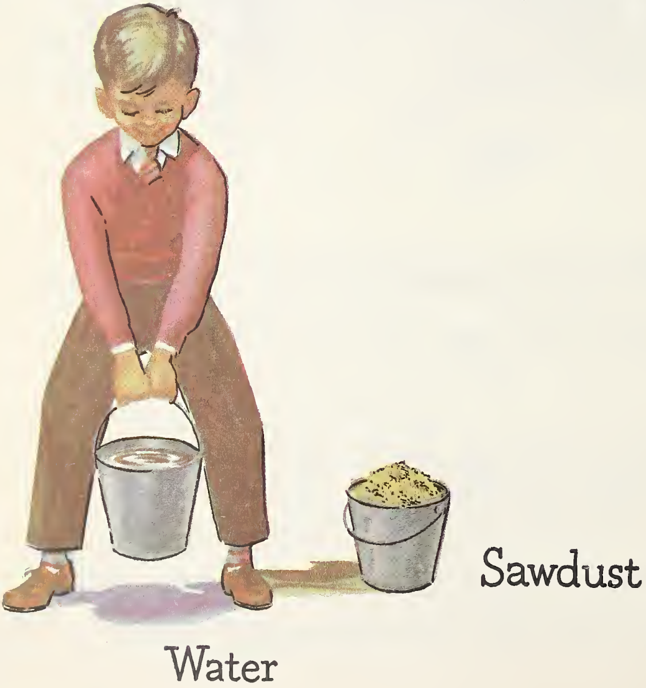
Make a list of ways to keep from being hurt by the pull of the earth.

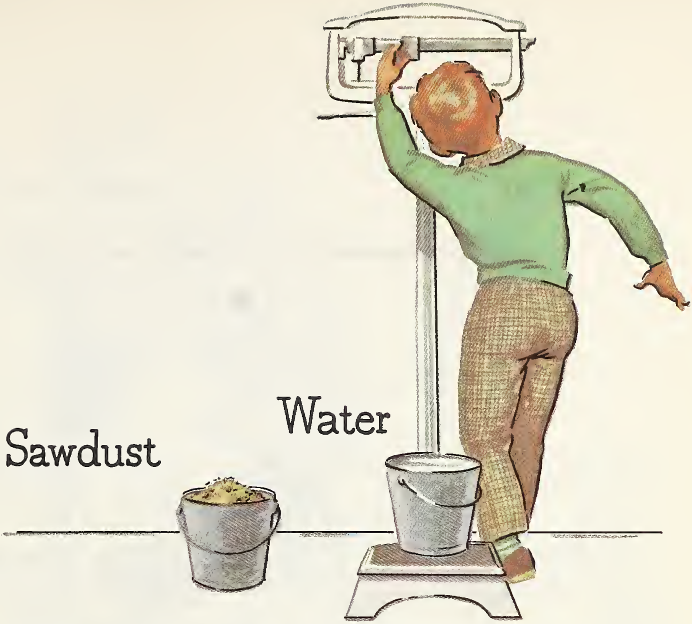
The Earth Pulls Some Things More Than Others

Pick up a pail of water.
Pick up a pail of sawdust.

Which is easier to pick up?
Can you tell why?

Try other things.





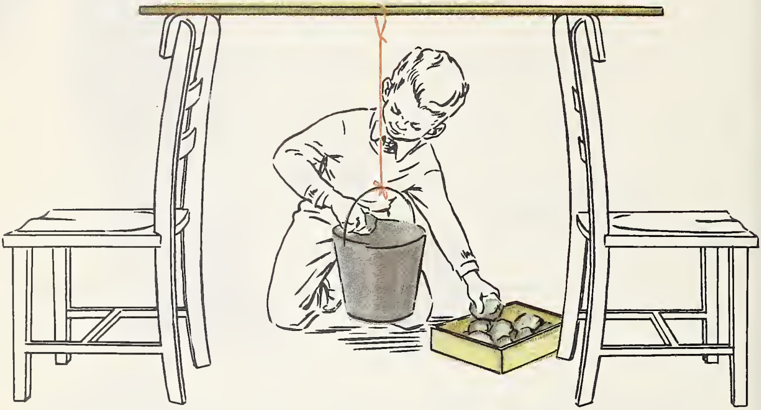
Measuring the Pull of the Earth

This is the way we measure the pull of the earth.

How much does the earth pull on the water?

How much does the earth pull on the sawdust?

How much does the earth pull on you?



Changing the Earth's Pull

Hang a pail by a small string.

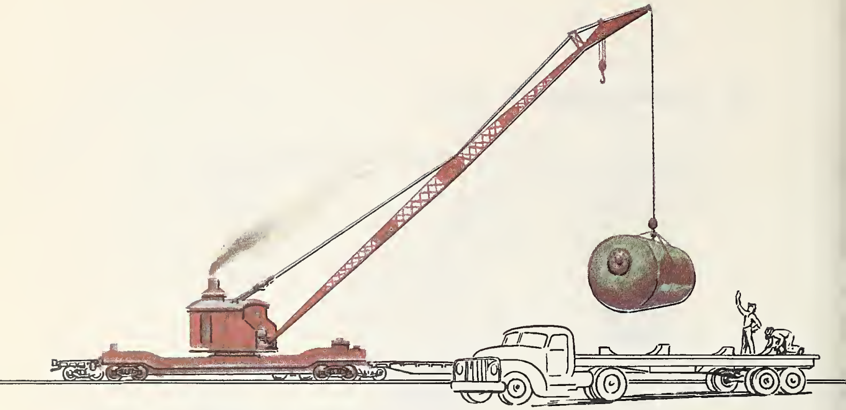
Put more and more stones in the pail.

What may happen?

Can you tell why?

Hang a pail from a spring.
Put stones in the pail.
What happens? Why?

Sometimes we measure
the pull of the earth with a spring.



Machines to Lift Things

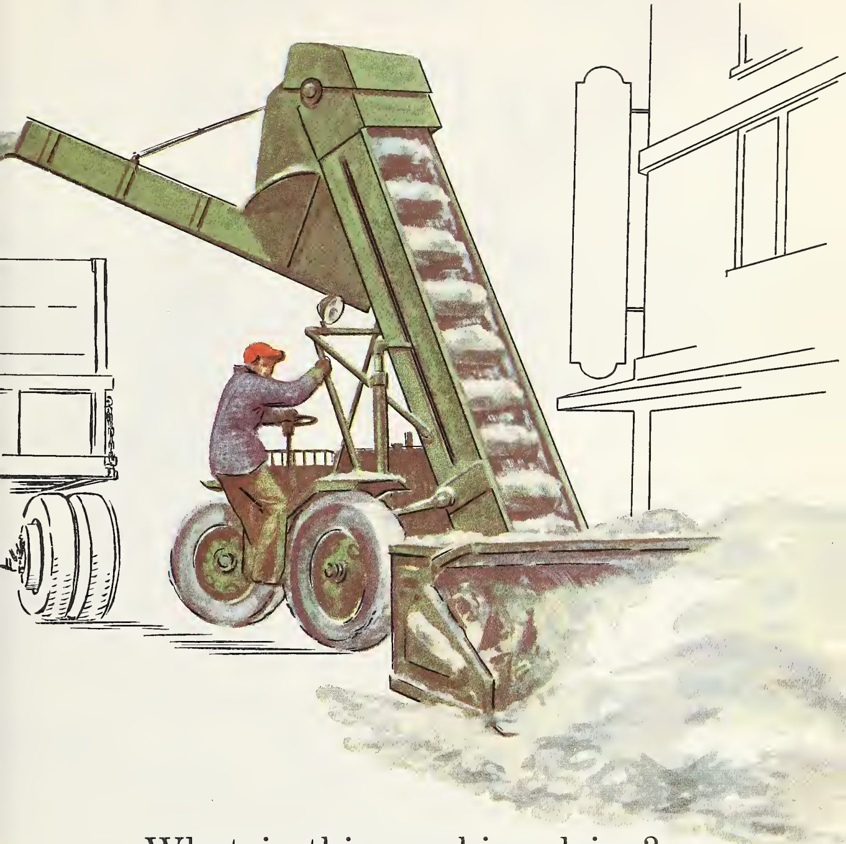
The earth pulls some things strongly.

It is hard to lift them.

Can you think of things that are hard to lift?

We often use machines to lift heavy things.

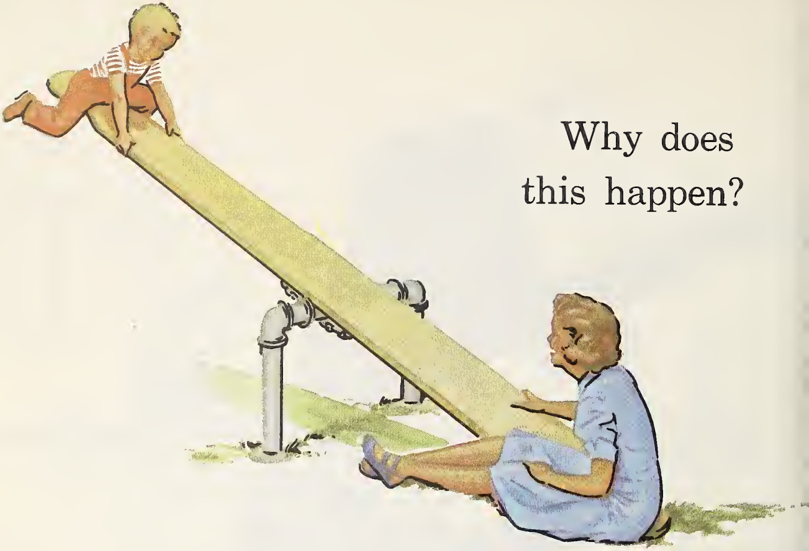
What is the machine in the picture doing?



What is this machine doing?

Name other machines
that lift things.

Bring in toys that lift things.



Why does this happen?

---

1. Why do things fall?
2. Why does a ball roll downhill?
3. How do we use the pull of the earth?
4. How may the earth's pull hurt us?
5. How do we measure the pull of the earth?
6. Name some machines that lift heavy things.

When We Run and Play

Breathing

John and Sally are running.
Show how they breathe
after they run.

John and Sally are resting now.
Show how they breathe
after they rest.

Breathe in
through your nose.
Breathe in
through your mouth.

Breathe out
through your nose.
Breathe out
through your mouth.

Find a soda straw.
Blow into a glass
of water.

What comes
from your mouth?

Air goes in and out
when you breathe.

John's Heart

John felt something inside him.

It went thump—thump—thump.

It was his heart beating.

Then he ran to school.

He felt his heart again.

It went thump—thump--thump—thump.

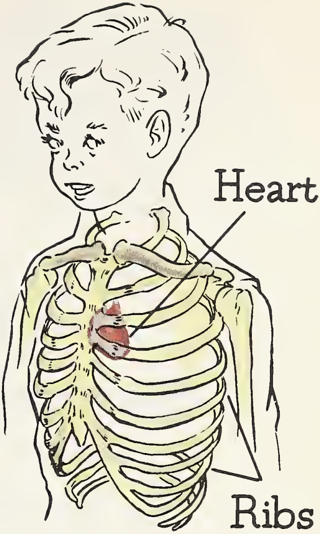
It went faster.

John's heart
is in his chest.

There are bones
around his heart.

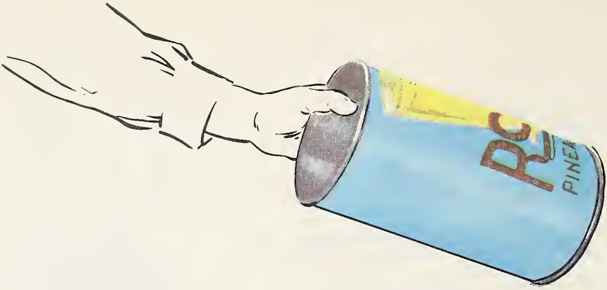
Show where
your own heart is.

Find the bones
around it.



Has a doctor listened
to your heart?

What did he do?



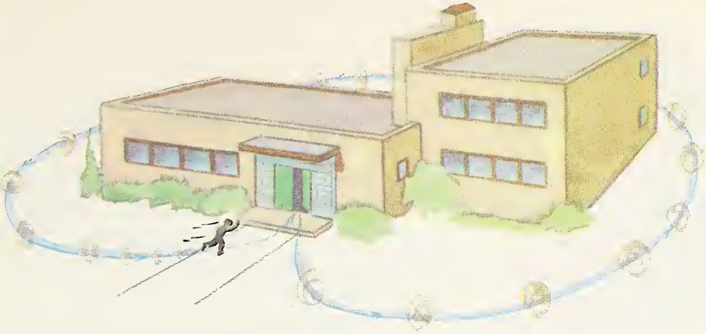
An Experiment

John brought an empty can
to school.

He put the open end
over Henry's heart.

He put his ear against the can.

He heard Henry's heart beat.



Then Henry ran around the school.
He ran as fast as he could.

Then John listened
to Henry's heart.

Henry rested
a few minutes.

John listened again.

When did Henry's
heart beat fastest?

When did Henry's
heart beat slowest?

Blood Tubes

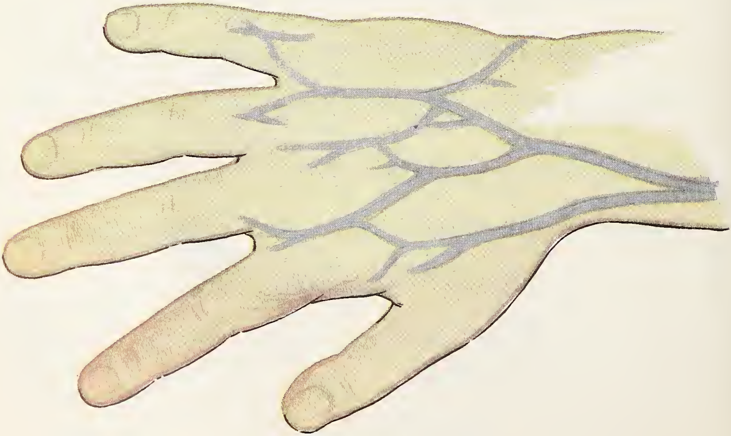
Your heart pumps blood
through your body.

Your blood
goes through tubes.

The blood tubes
go to all parts
of your body.

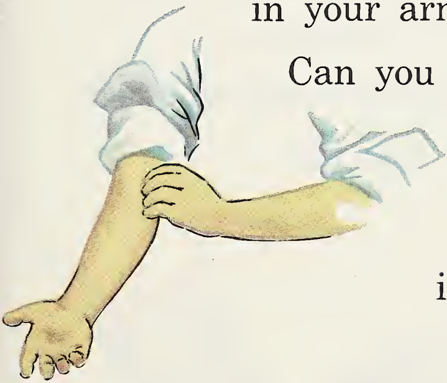
You can see the blood tubes
in your hand.

Have you seen other blood tubes
in your body?

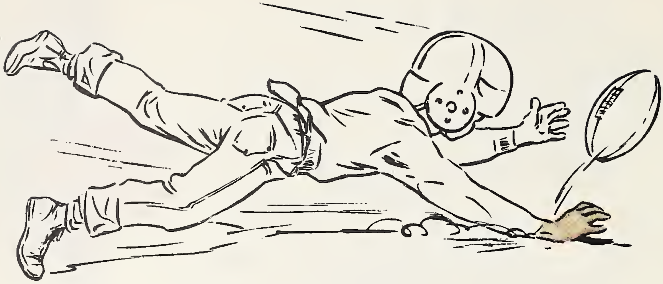


There are
blood tubes
in your neck.
They carry blood
to your head.
Put your fingers
on your neck.
What do you feel?

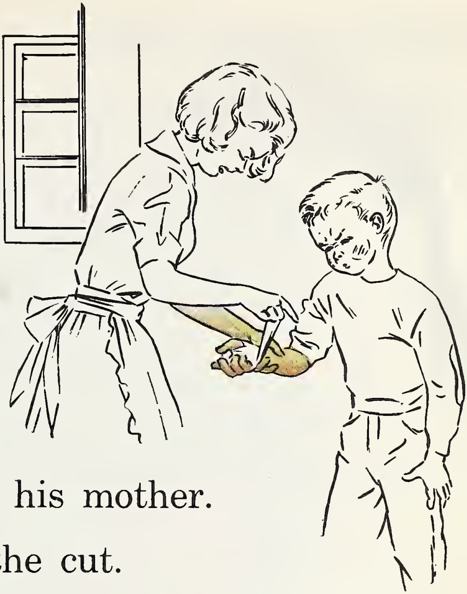
Blood goes through a tube
in your arm.
Can you feel it?



Blood goes
into your hand.
Can you feel it?



One day John was playing ball.
He fell and cut his hand.
He cut some of the blood tubes.
A little blood came out.



John went to his mother.

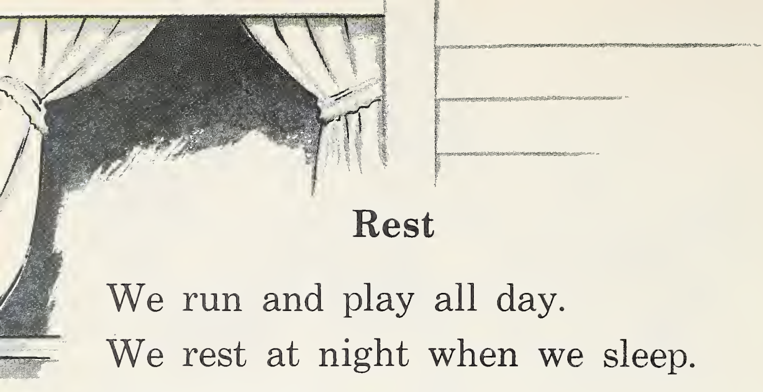
She cleaned the cut.

She covered the cut.

In a few days
his hand was well again.

Clean cuts
get well fast.

Dirty cuts
may not get well.



Rest

We run and play all day.

We rest at night when we sleep.

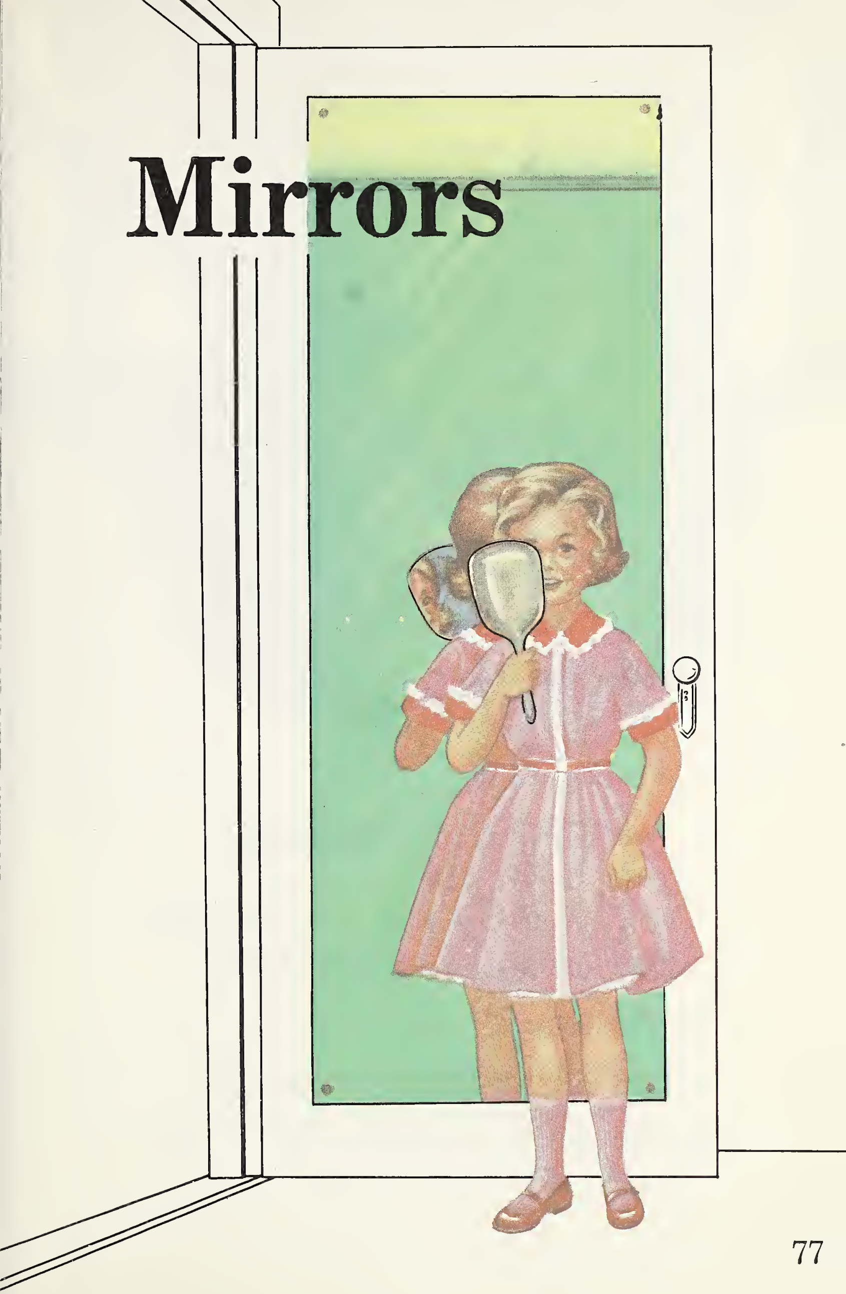
What should we do
so that we will sleep well?

When else do we rest?

---

1. When do we breathe very fast?
2. Where is your heart?
3. How does blood go through your body?
4. What goes in and out when you breathe?
5. Why should you take good care of cuts?
6. What does your heart do?
7. When do you rest best?

Mirrors

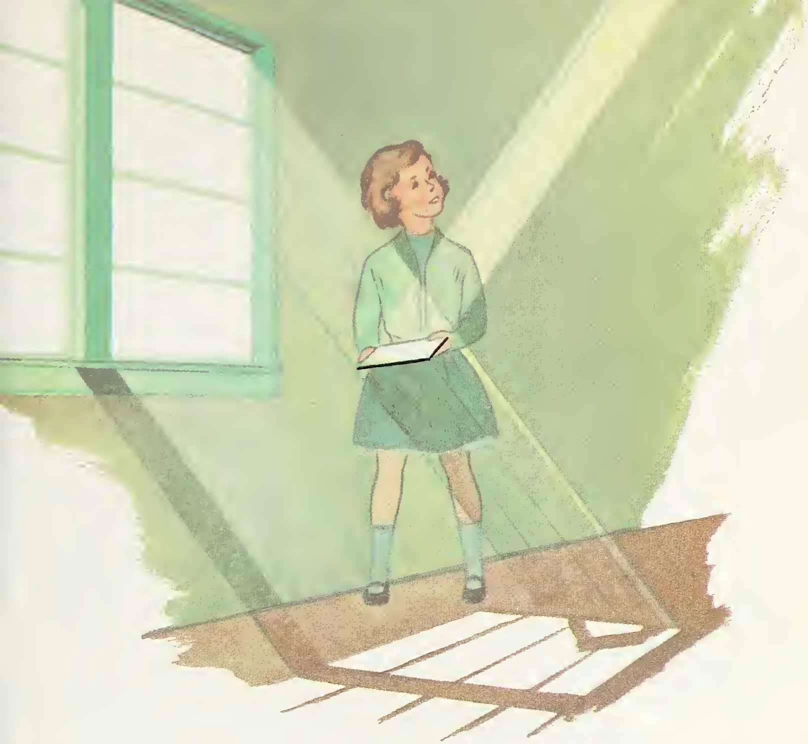


Mirrors and Sunlight

Hold a mirror in the sunlight.

Do you see a spot of light on the wall?

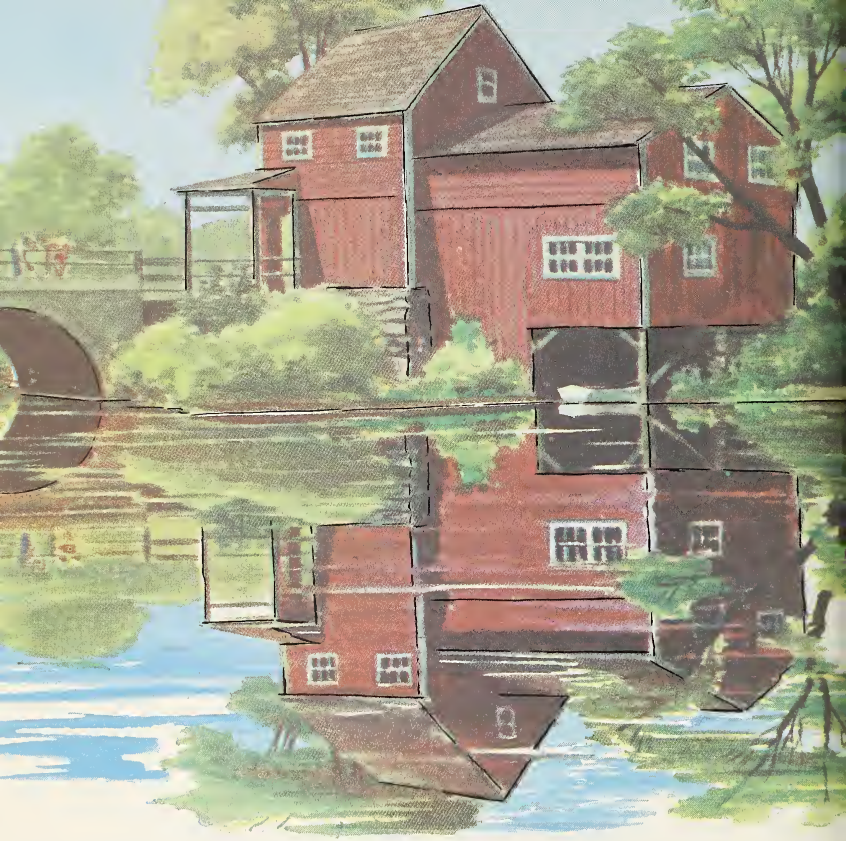
The mirror reflects sunlight to the wall.



Move the mirror.

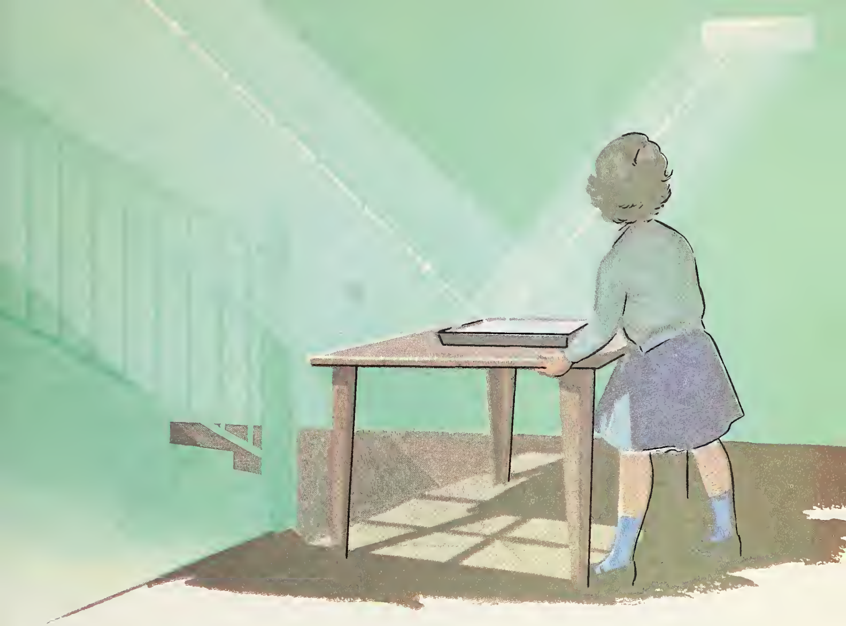
What happens to the spot of light?

The mirror reflects light to a new place.



Other Kinds of Mirrors

Look at this picture.
Turn it upside down.
Can you explain it?



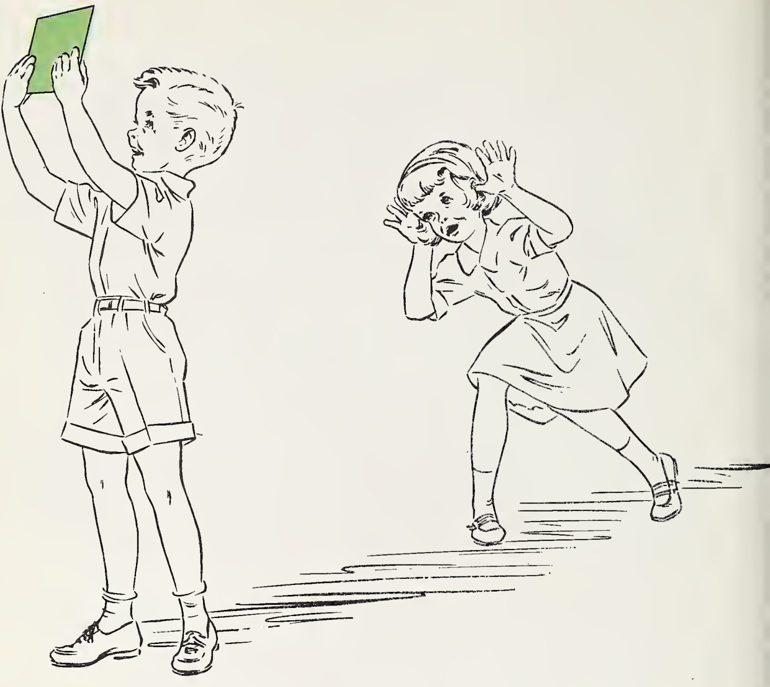
Put a pan of water
in the sunlight.

Does water reflect sunlight?

Put a piece of shiny metal
in sunlight.

Does it reflect sunlight?

Find other things
that reflect sunlight.



Fun with Mirrors

The boy can see
what is behind him.

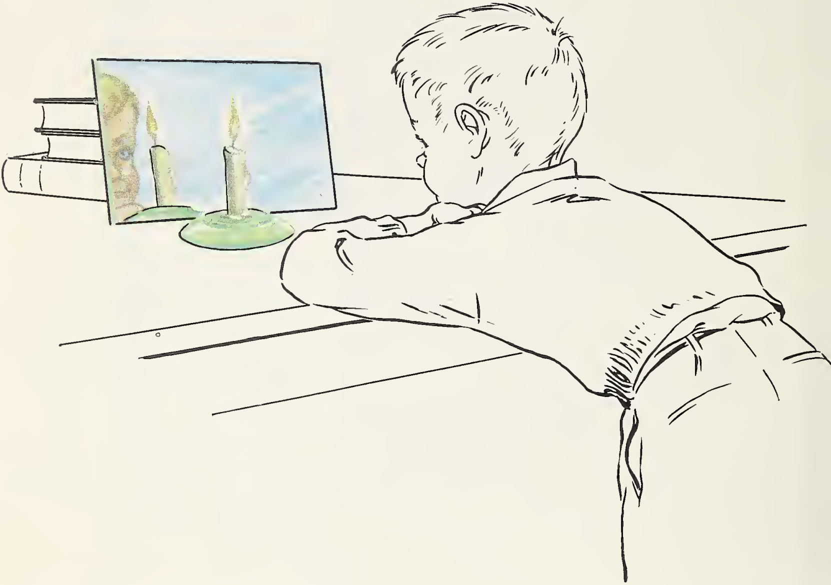
Hold a mirror the same way.
Look in the mirror.
Can you see what is behind you?

The girl is holding a mirror
in the doorway.

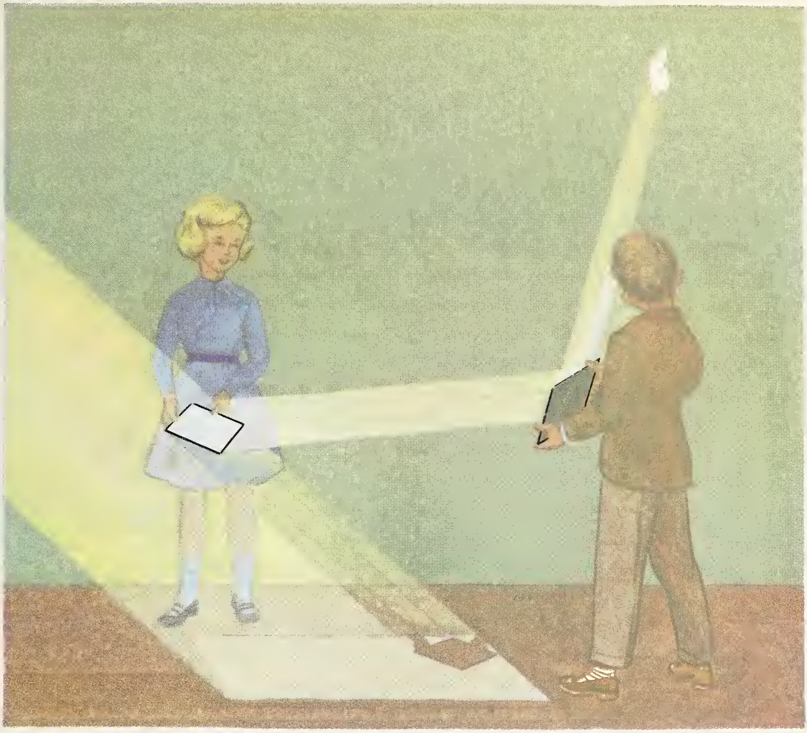
She can see things behind the wall.

Try to do this.

Can you see things
behind the wall?



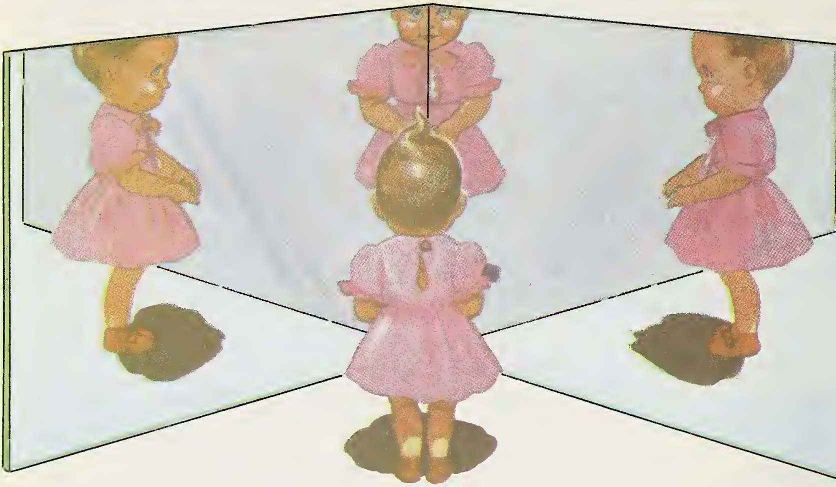
This boy can see two candles.
He sees the real candle.
He sees the candle in the mirror.
Try to do this.



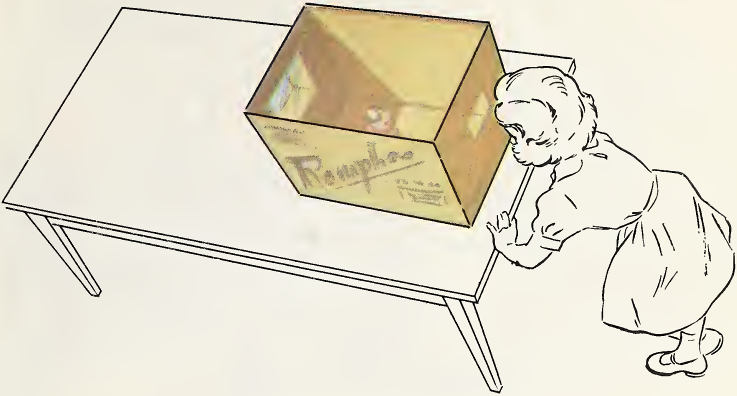
How many times
is the light being reflected?

Can you do this too?

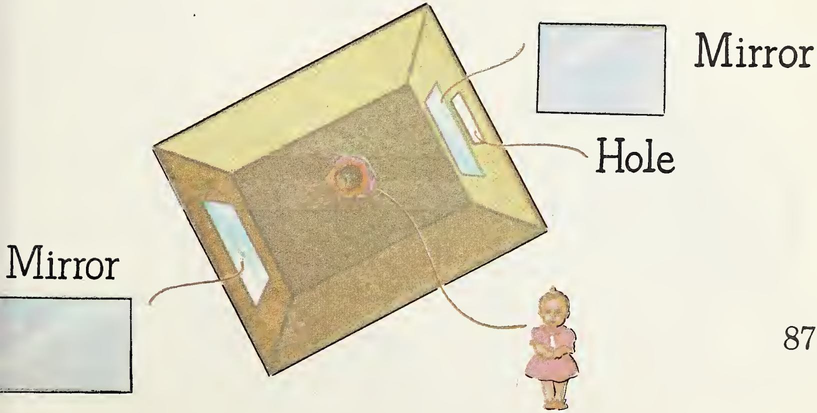
How can you reflect light
three times?



Put two mirrors together like this.
Put a doll in front of the mirrors.
How many dolls do you see?
Turn one mirror a little.
How many dolls do you see?



Put a mirror in each end of a box.
Cut a hole over one mirror.
Put a doll in the middle of the box.
Look through the hole.
How many dolls can you see?

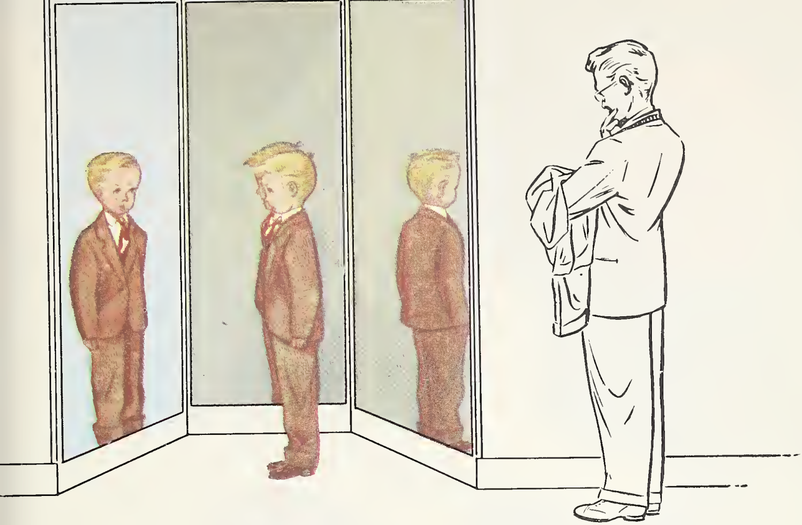


Using Mirrors

Here are some ways we use mirrors.

Why is there a mirror in an automobile?

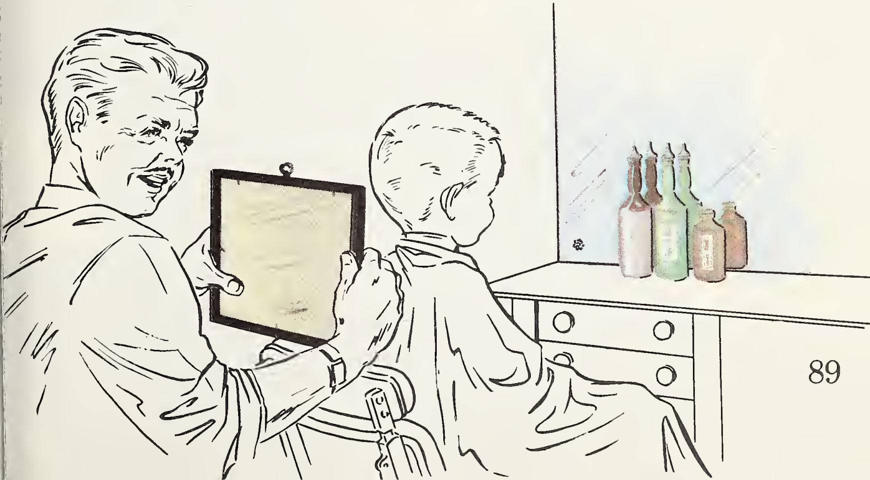
Why does a dentist use a mirror?

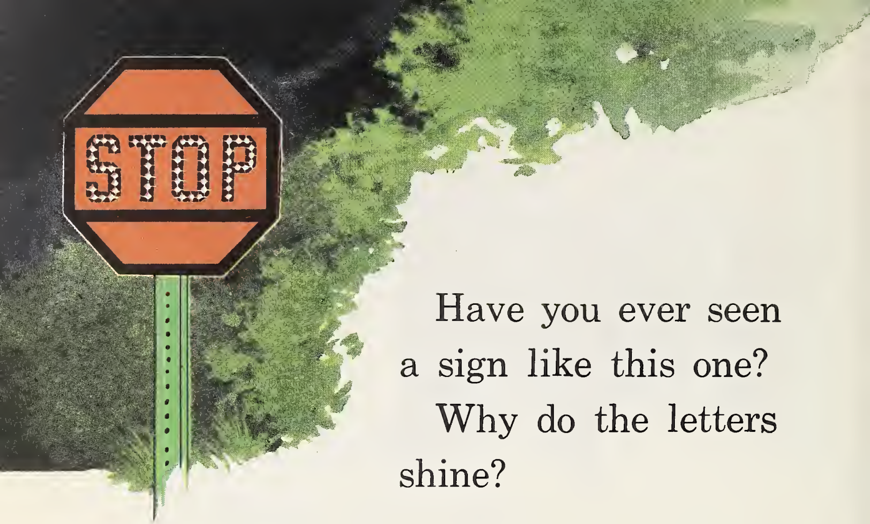


Have you ever seen a mirror like this one?

Where did you see it?

Why does a barber hold a mirror like this?





Have you ever seen a sign like this one?

Why do the letters shine?

---

1. What does a mirror do?

2. What are some other things that reflect light?

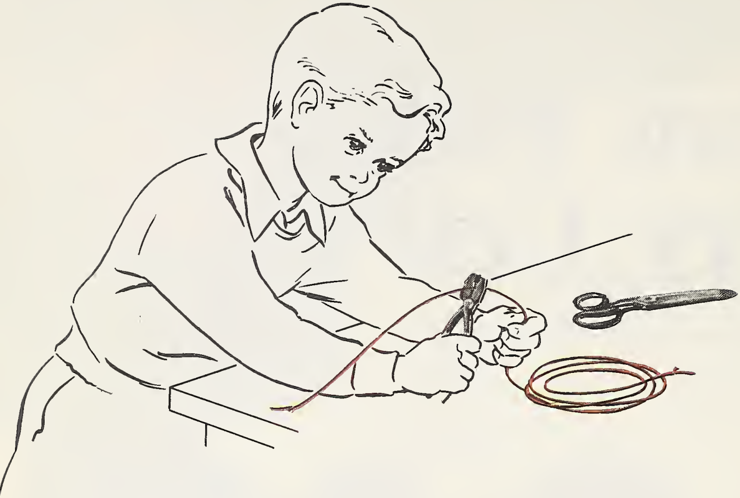
3. How can you see the back of your head?

4. How can you see behind a wall?

5. How can you reflect light two times?

6. What are some ways we use mirrors?

Fun with a Dry Cell



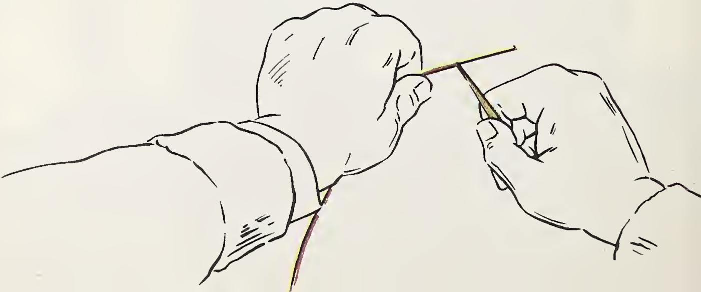
Lighting an Electric Lamp

Would you like to light
an electric lamp?

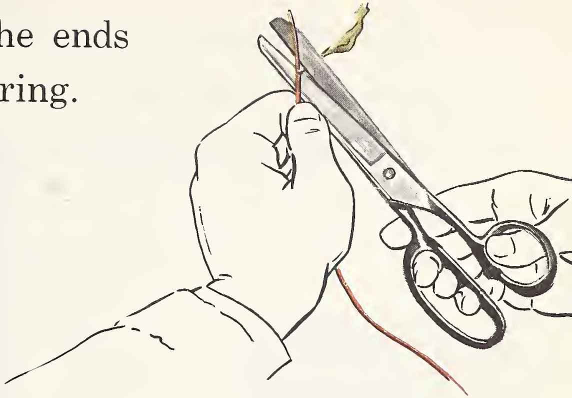
These pictures show you how.

First cut two pieces of wire.

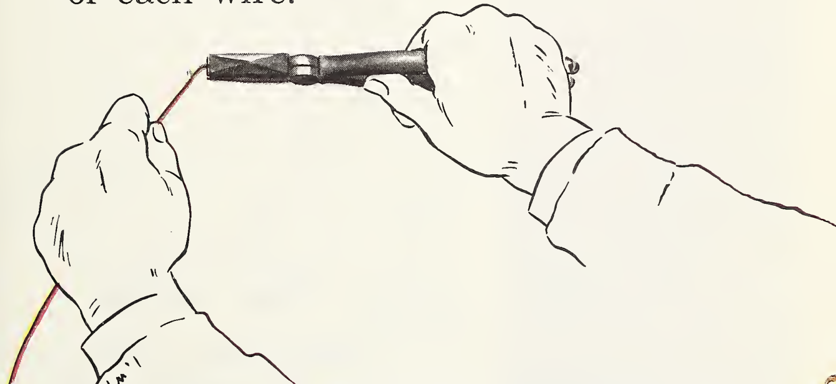
Take some covering from the ends
of the wires.



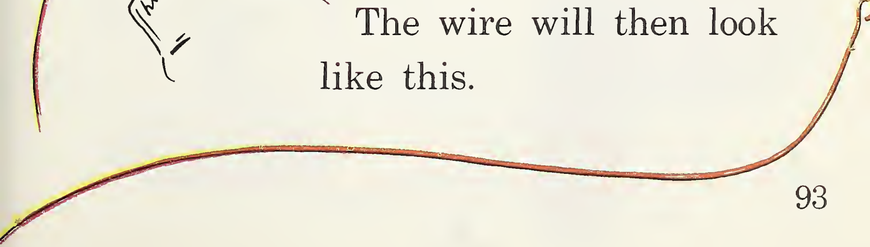
Cut off the ends
of the covering.



Bend one end
of each wire.

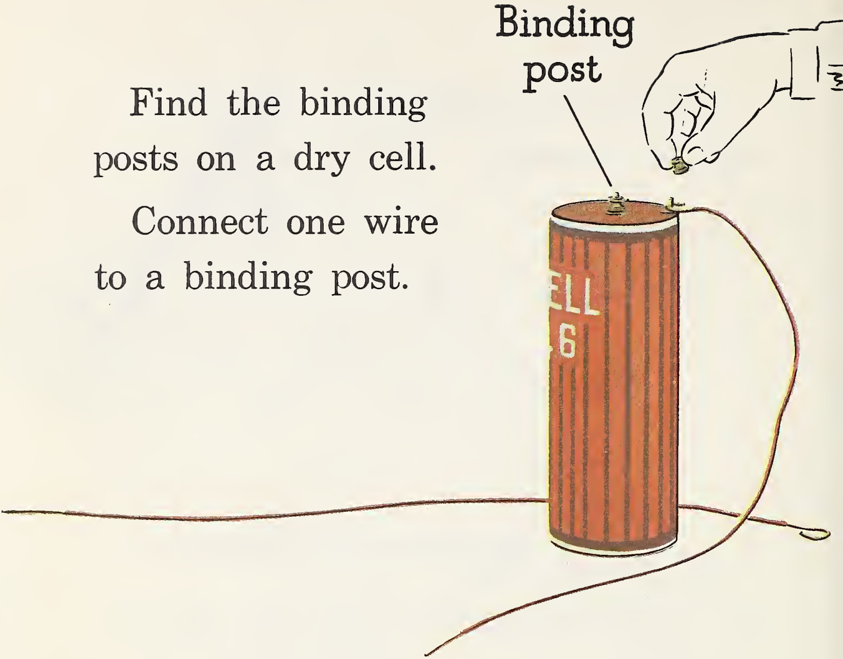


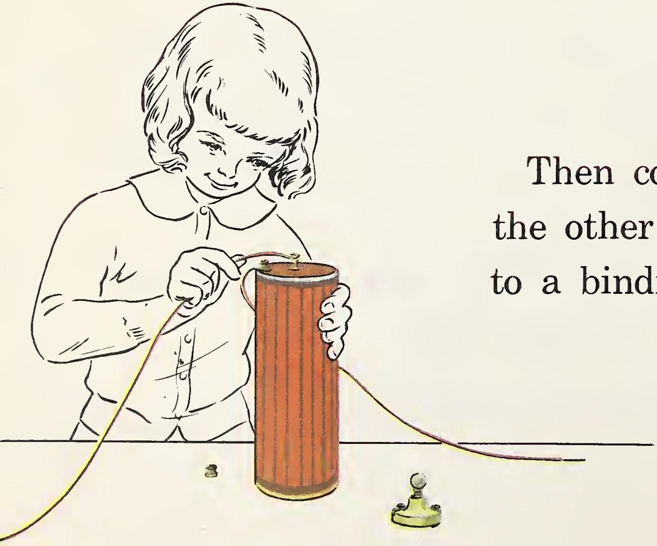
The wire will then look
like this.



Find the binding posts on a dry cell.

Connect one wire to a binding post.



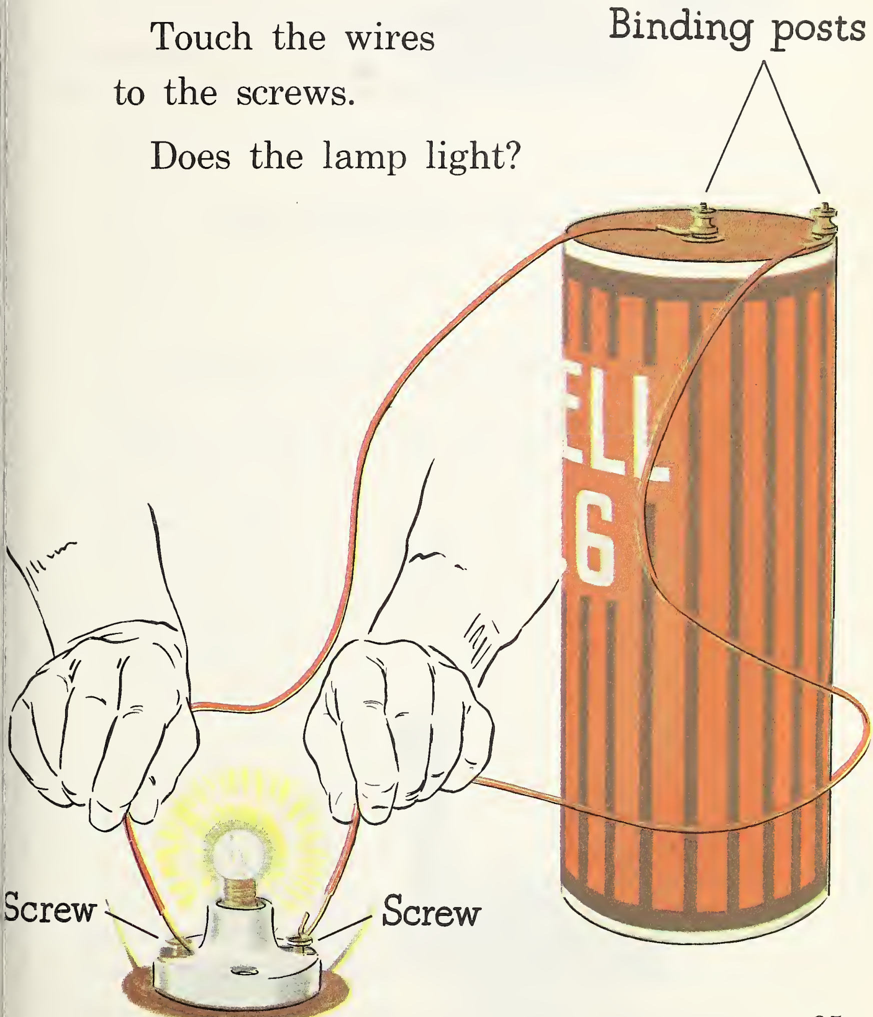


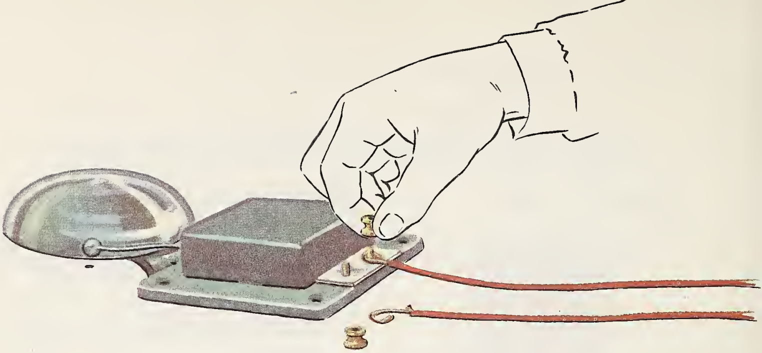
Then connect the other wire to a binding post.

Find the screws
on a lamp.

Touch the wires
to the screws.

Does the lamp light?



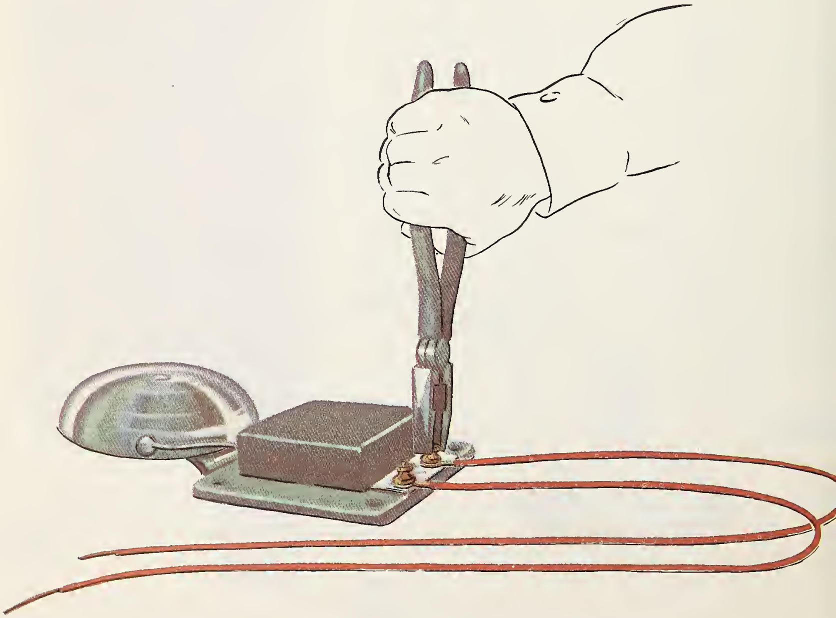


Ringing an Electric Bell

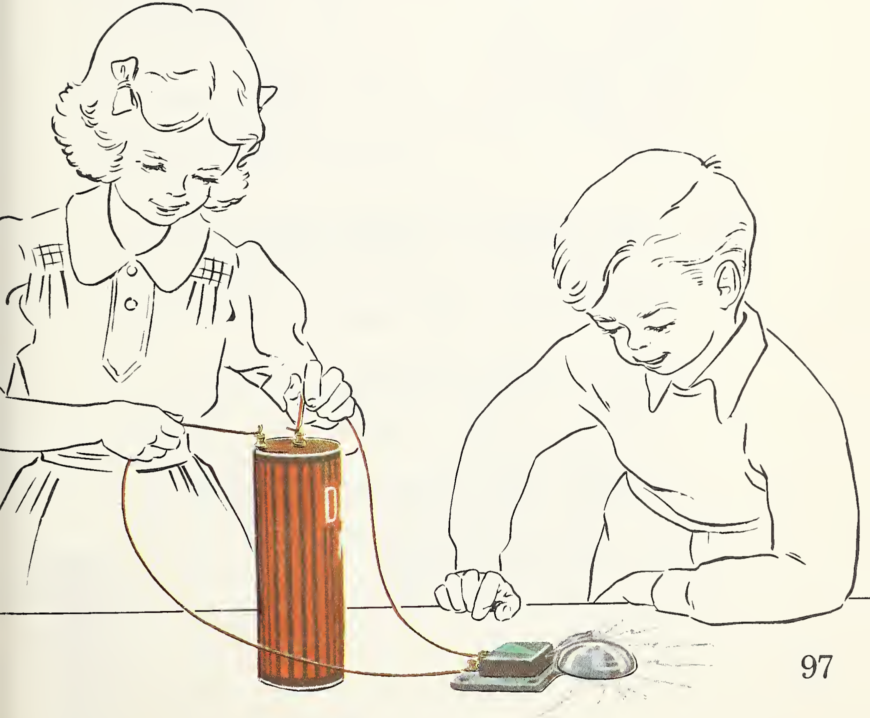
Use two wires.

Find the binding posts on the bell.

Connect a wire to each binding post.



Touch the wires
to the binding posts
of the dry cell.
Does the bell ring?



Lighting a Doll House

This boy and girl
made a doll house.

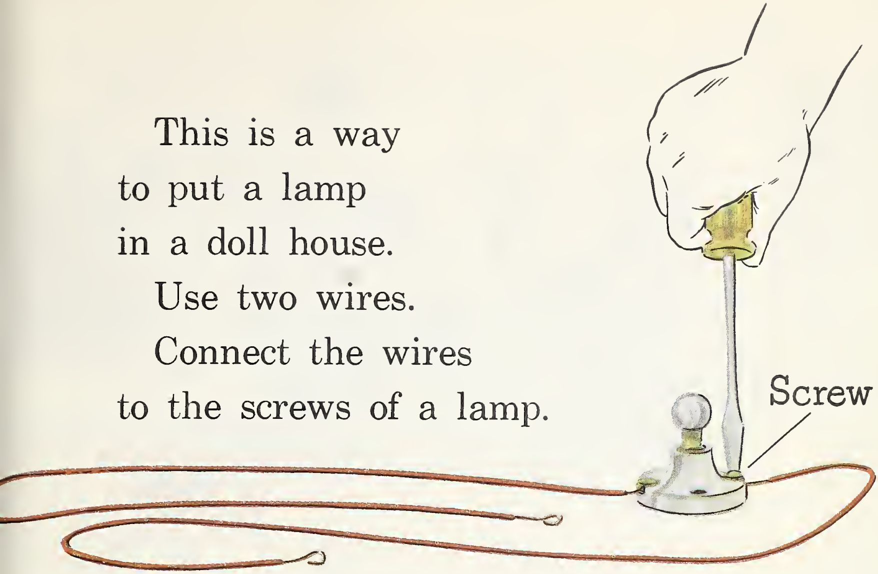
They made it from a box.

They put an electric lamp
in the doll house.

This is a way
to put a lamp
in a doll house.

Use two wires.

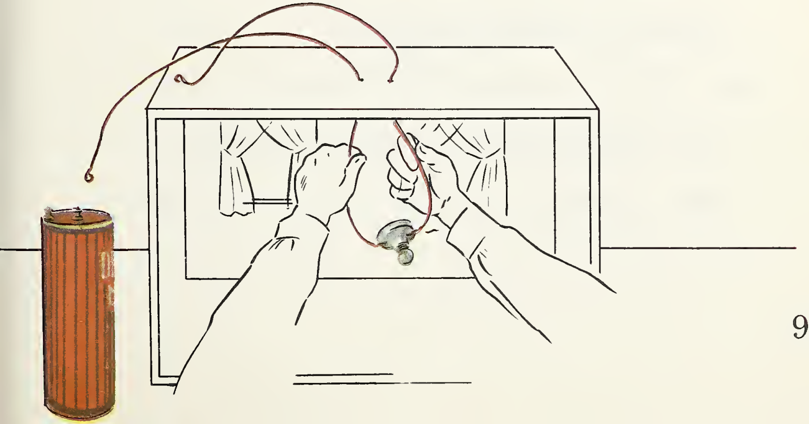
Connect the wires
to the screws of a lamp.

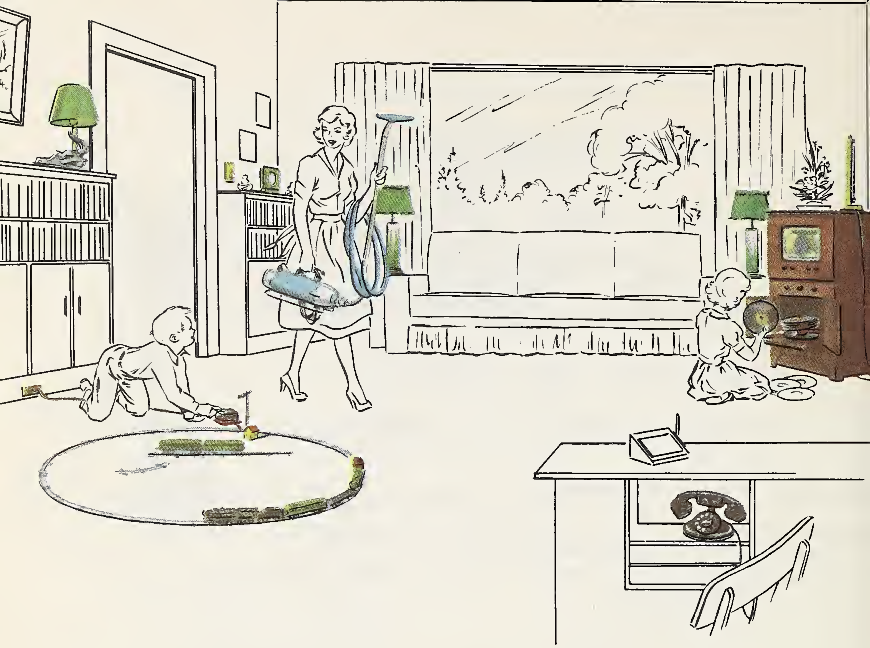


Make two holes in the top
of the doll house.

Push the wires through the holes.

Connect the wires to a dry cell.





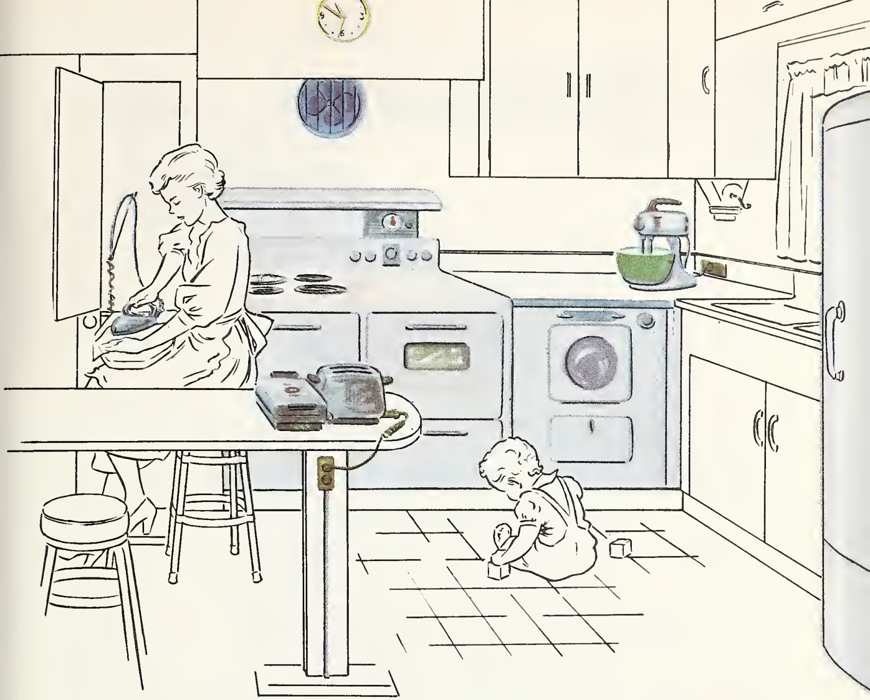
Using Electricity at Home

This picture shows some ways electricity is used.

Sometimes you can see the wires.

Sometimes the wires
are in the walls.

This electricity is very strong.
Be careful with it.

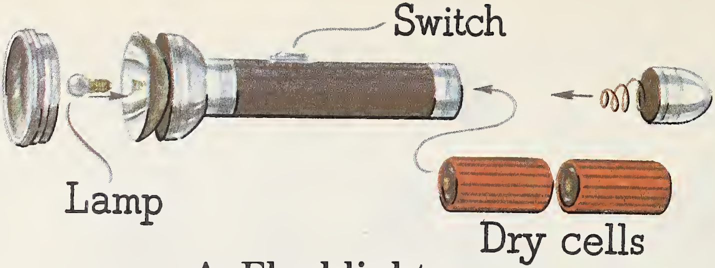


Here are more ways
electricity is used.

How is electricity used at home?

How is electricity used
in an automobile?

What are some other ways
electricity is used?



A Flashlight

There is an electric lamp in a flashlight.

There are dry cells in a flashlight.

Look for them.

---

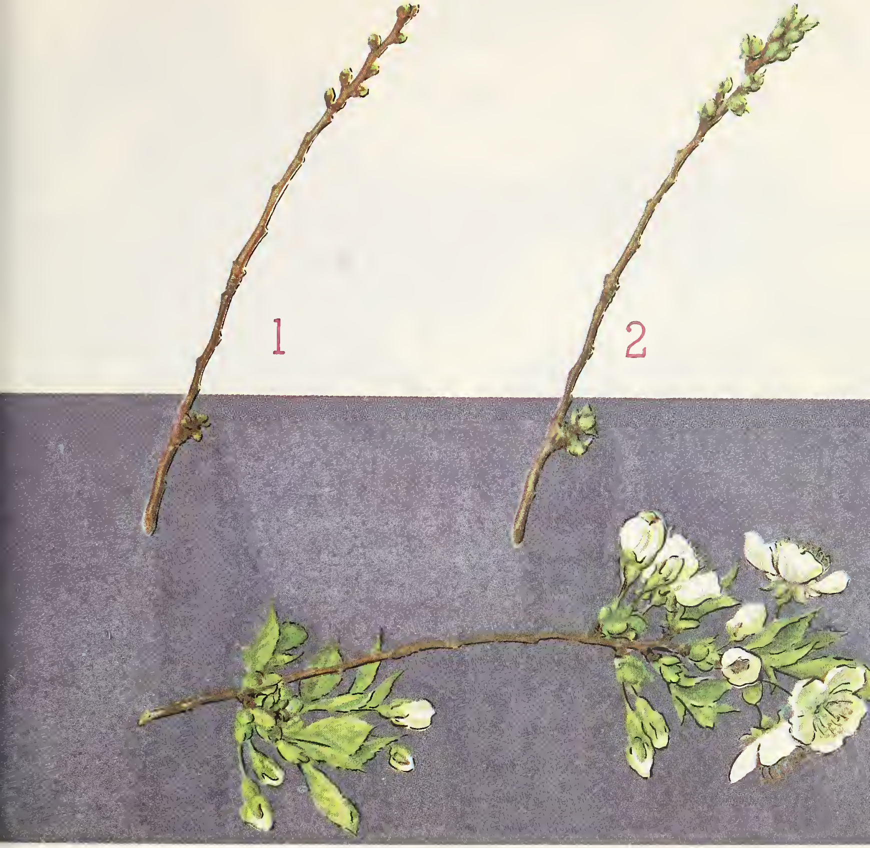
1. How many binding posts are there on a dry cell?
2. How many binding posts are there on a bell?
3. How many wires were used to light a lamp?
4. What are two things electricity did for you?
5. What are some things electricity does in your home?

Buds

Buds in the Schoolroom

Twigs of trees
have little buds.

Cut some twigs from a tree.
Put them in water.
Watch them every day.

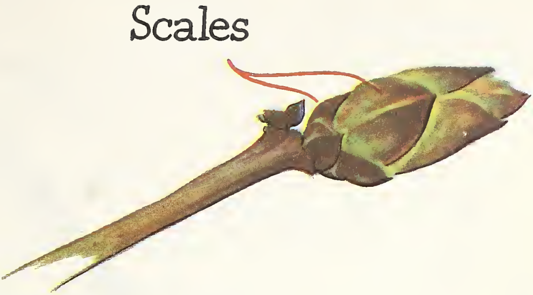


These twigs are from a cherry tree.
The buds grow bigger every day.
Soon the buds open.
Flowers come from some of the buds.

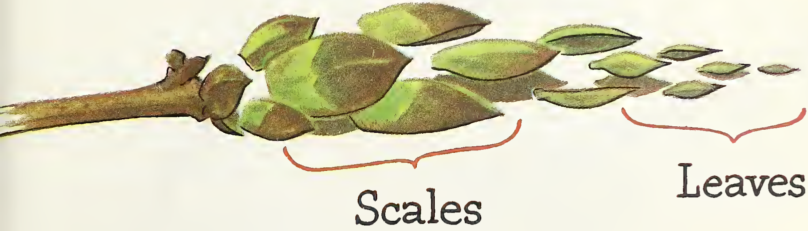
What Is in a Bud?

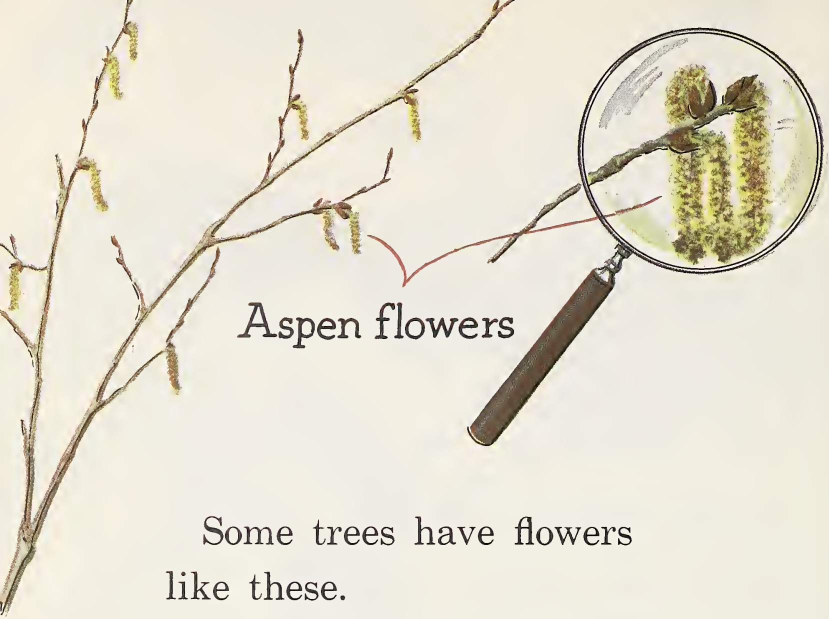
Flowers grow
from some buds.

Leaves grow
from some buds.



Take apart a big bud.
Find the scales around the bud.
Find the leaves inside the bud.
The scales open and fall off in the spring.
Then the little leaves begin to grow.





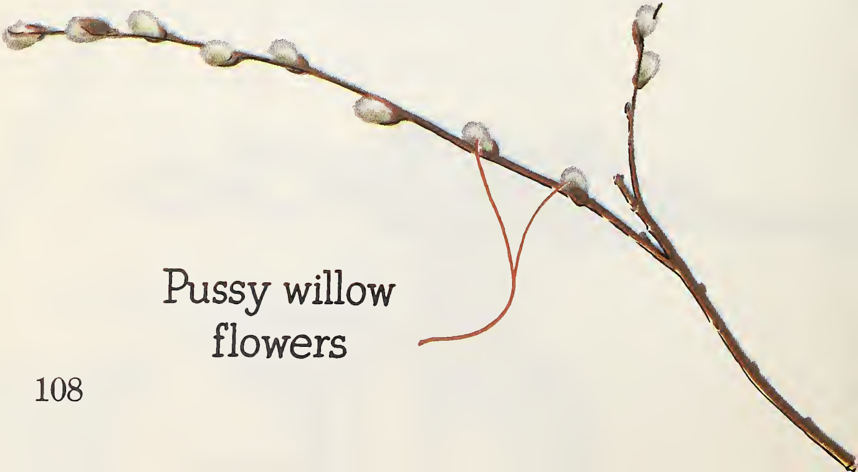
Aspen flowers

Some trees have flowers
like these.

Look for them in the spring.

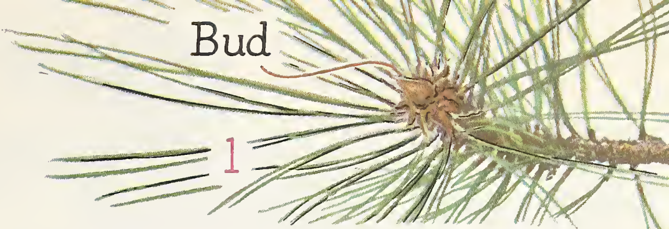
Try to find some of the buds.

Bring them in
and watch them open.



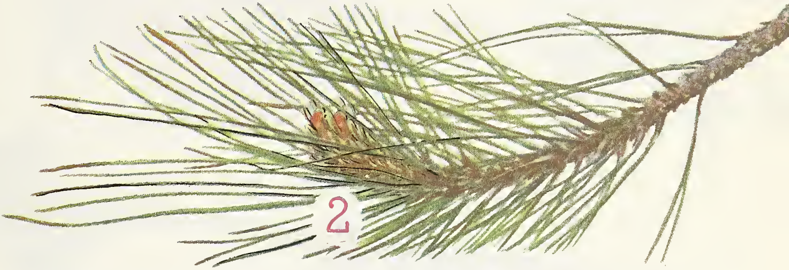
Pussy willow
flowers

Bud



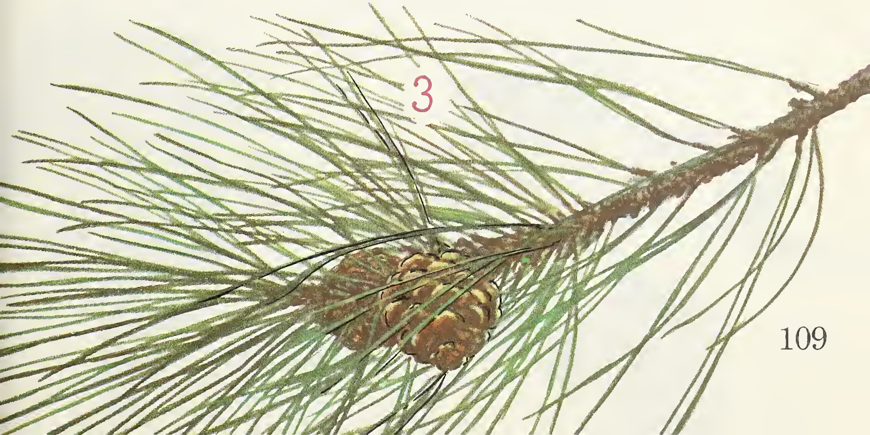
Look for buds on evergreen trees.

Some of the buds
will become new twigs.



Needles will grow on the new twigs.

Watch evergreen tree buds
this spring.

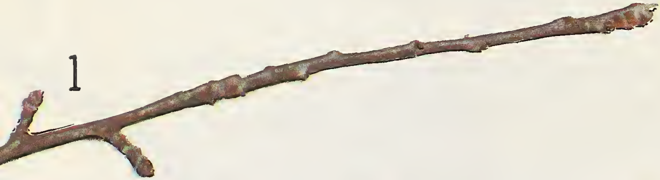


The Story of an Apple Twig

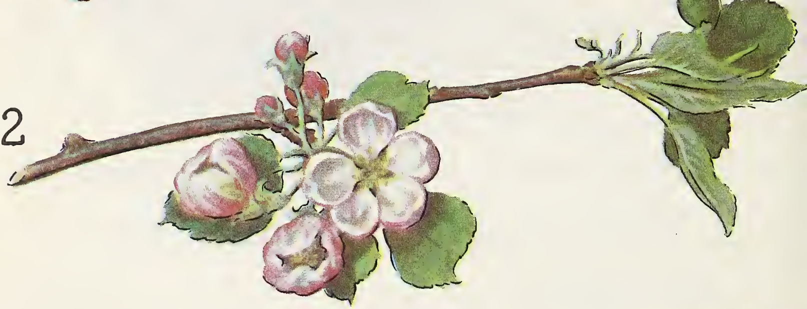
All winter there are buds
on apple trees.

The buds open when spring comes.

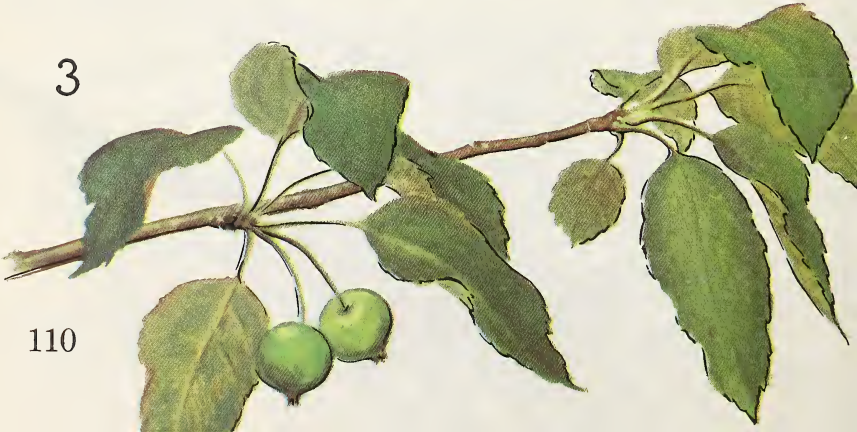
1



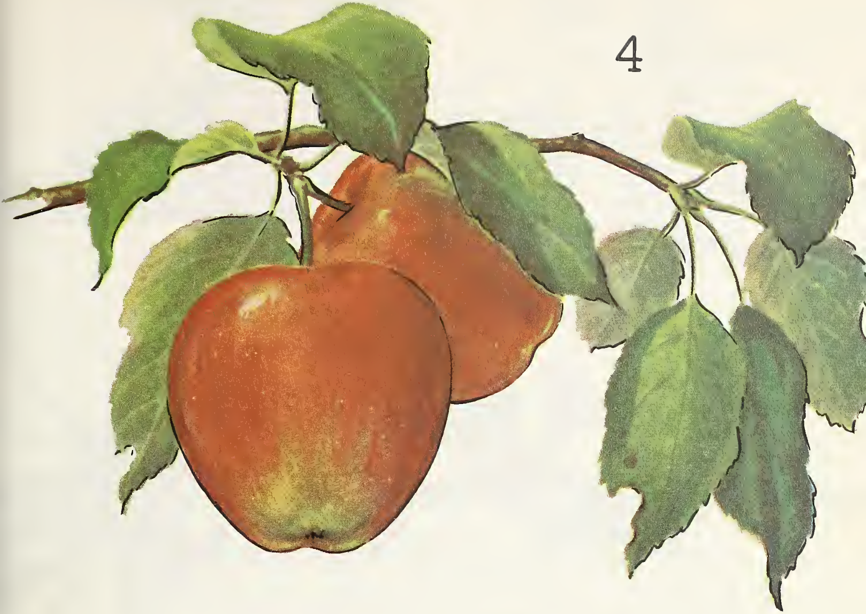
2



3



4



Leaves grow from some buds.

Flowers and leaves
grow from other buds.

Little apples grow from flowers.

The apples grow bigger
and bigger.

At the end of the summer
the apples are ripe.

Fruits from Other Kinds of Trees

1

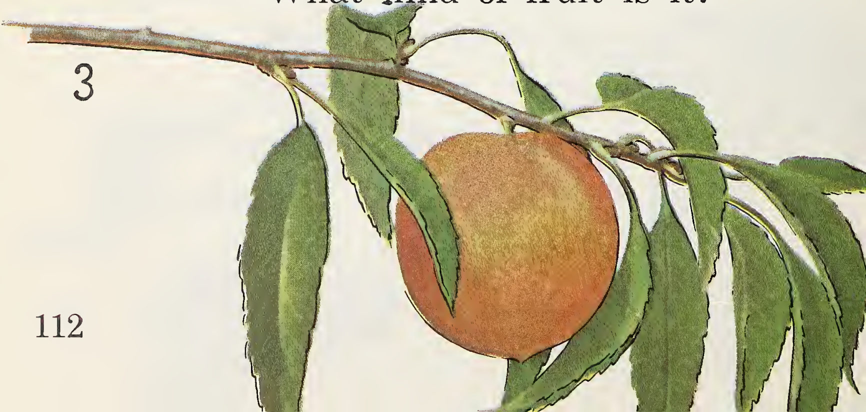
Here are buds on another twig.

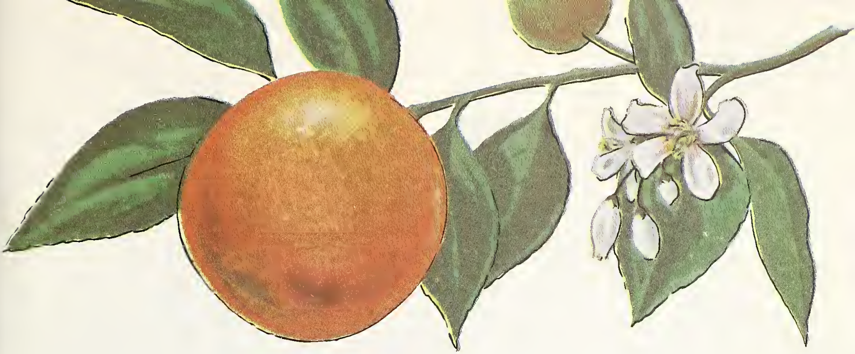
2

Here are flowers
that come from the buds.

The fruit in this picture
grew from one of the flowers.
What kind of fruit is it?

3

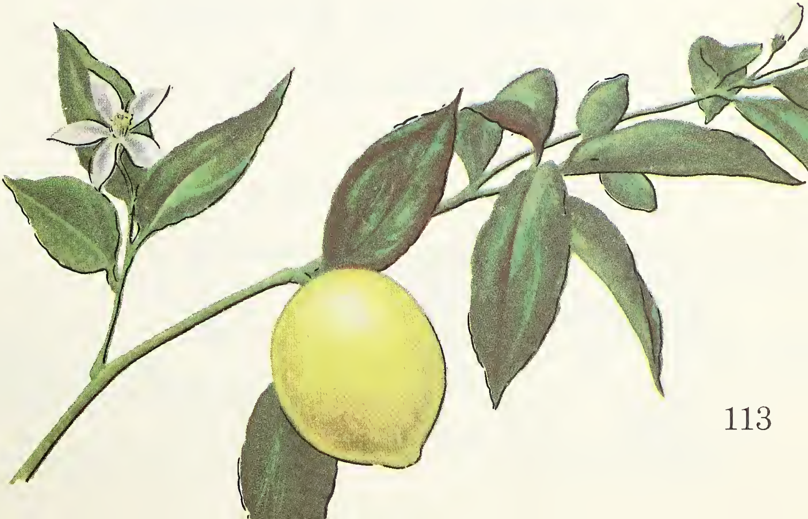




We can find buds, flowers, and fruit at the same time on some trees.

Here are twigs
from two of these trees.

What are they?



Animals That Eat Buds

Sometimes snow lies deep on the ground.

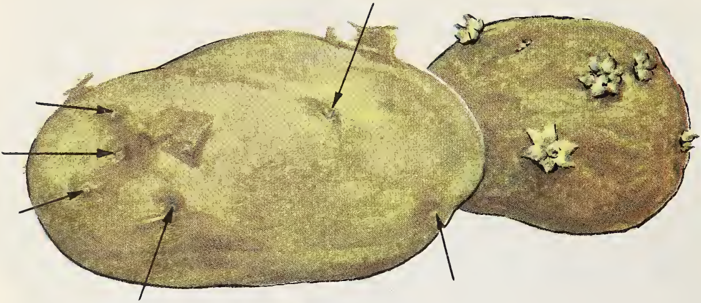
It covers food that many birds eat.

Some of these birds eat the buds of trees.

There are not many green plants in winter.

Deer and rabbits keep alive by eating buds.

They eat bark and twigs, too.



There are buds on potatoes.
The buds are called "eyes."
New stems come from the eyes.

Look for potato buds
that are beginning to grow.

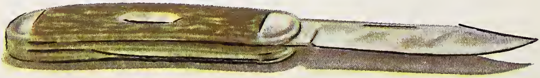
---

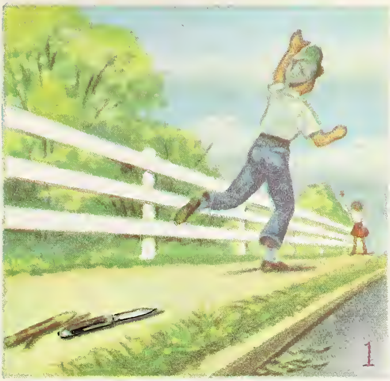
1. What may grow from a bud?
2. When do buds usually open?
3. How can you make buds open sooner?
4. What animals eat buds?
5. How do apples grow?

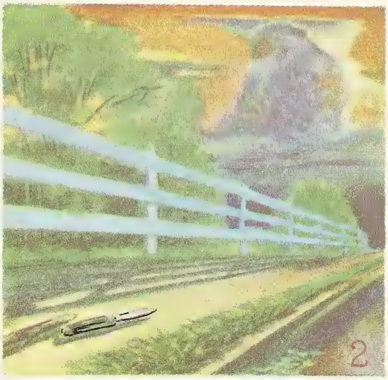
Rust

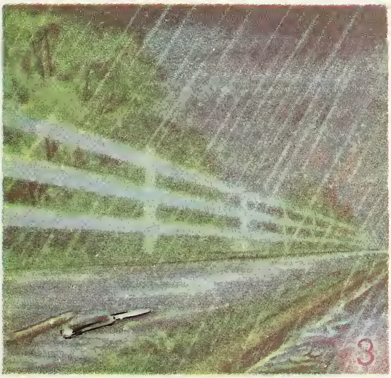
The Story of Tom's Knife

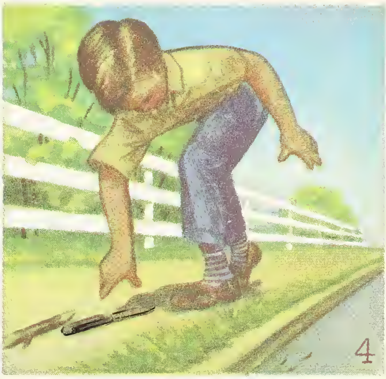
Tom had a new knife.
He got it for his birthday.
The knife was very sharp.
Tom liked his knife very much.
But one day Tom lost his knife.





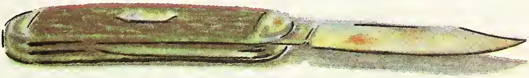






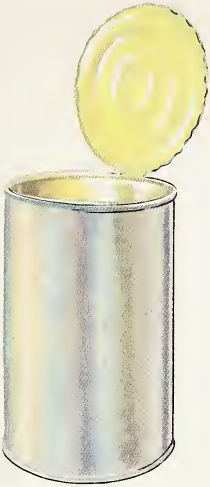
Look at the pictures.

Can you tell what happened to Tom's knife?

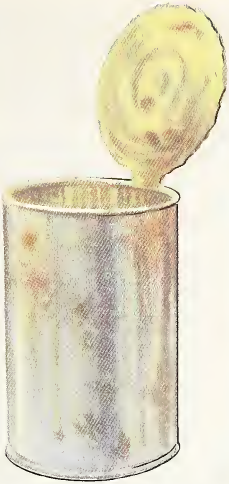


What Makes Nails Rust?

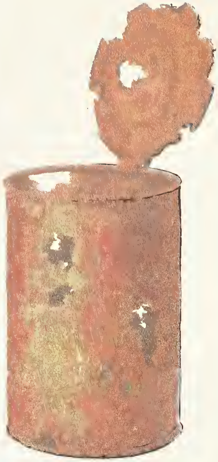
Fill a jar with dry sand.
Fill a jar with wet sand.
Put two nails in each jar.
Look at the nails every day.
What happens?



1



2



3

Here are three cans.

One can is new.

One can has been in a wet place a short time.

One can has been in a wet place a long time.

Which can is new?

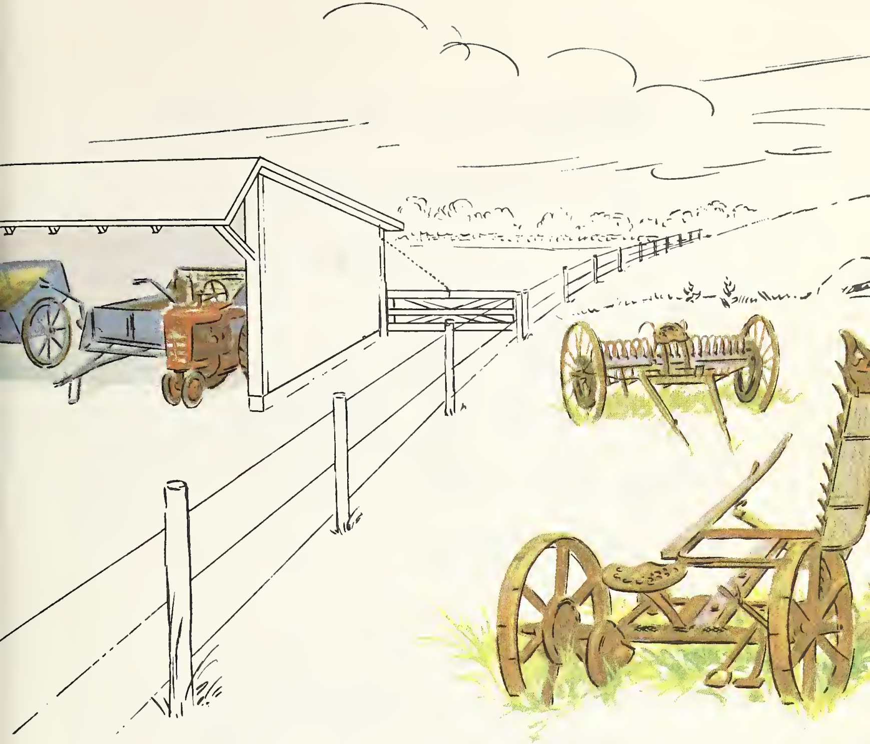
Find some cans like these.

Bring them to school.

It is raining.

The children are taking their toys indoors. Why?

Their father is drying his garden tools. Why?



Which farmer takes better care of his tools?

Which tools will last longer?

Why?

Things That Do Not Rust

Fill a jar with wet sand.

Put some pennies in the sand.

Put in some dimes.

Put in some nails.

Look at them the next day.

Which ones rust?

Try other things.

Can you pick up nails
with a magnet?

Can you pick up a knife
with a magnet?

Can you pick up other things
that rust?

A magnet picks up things
made of iron.

Things made of iron often rust.

Oil on Tools

Fill a jar with wet sand.
Put two nails in it.

Rub some oil on two nails.
Put them in the wet sand.
Look at the nails the next day.
What happens?

This man has clean, shining tools.

He puts oil on the tools.

The oil keeps the water
off the tools.

Why does this
keep the tools shining?

These men are painting a bridge.

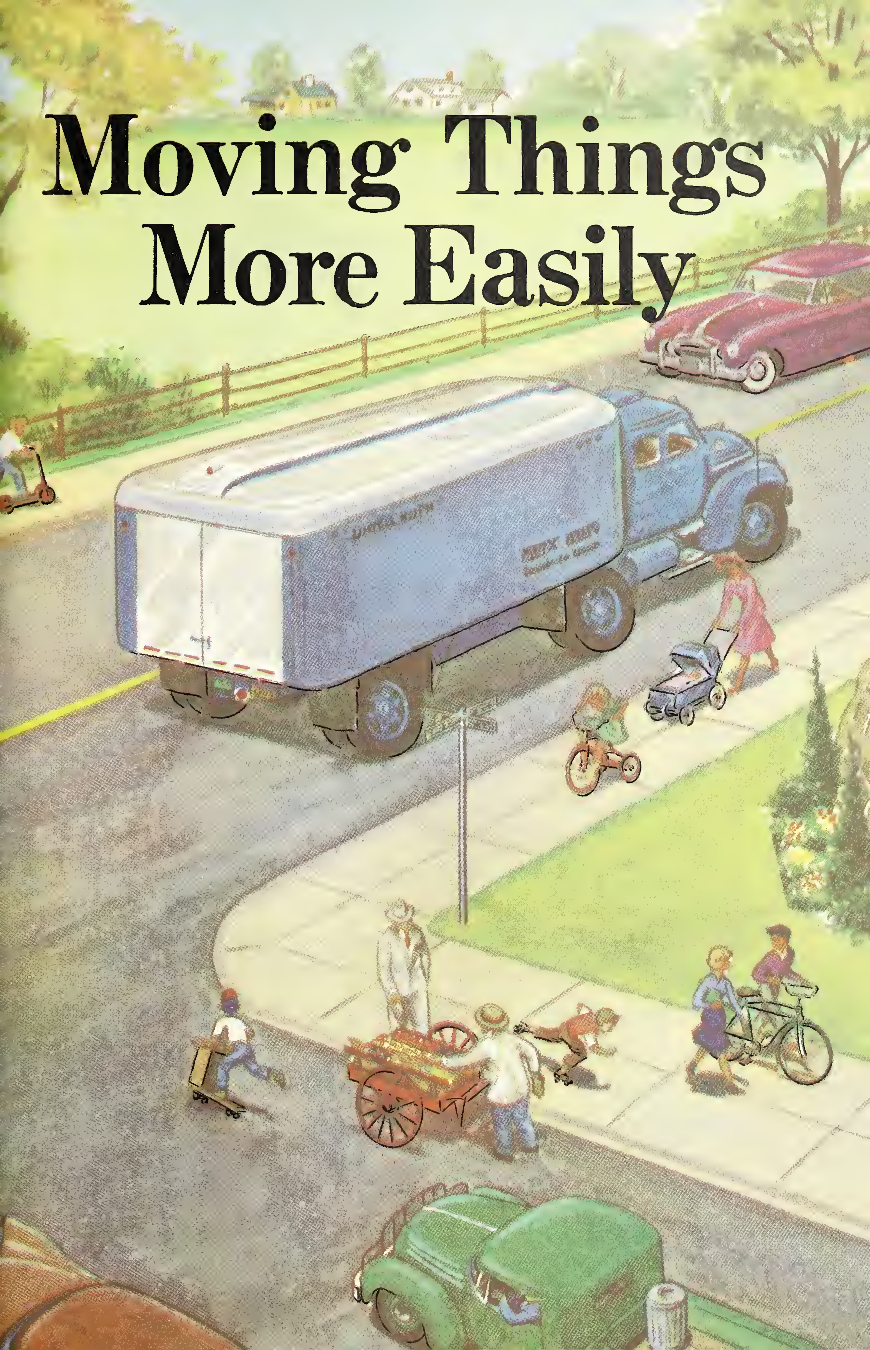
Paint keeps rain water from the iron in the bridge.

Paint keeps the bridge from rusting.

---

1. What are things that rust made of?
2. Why should tools be kept dry?
3. How can you tell if things are made of iron?
4. Why do we put oil on tools?
5. What things do not rust?

Moving Things More Easily

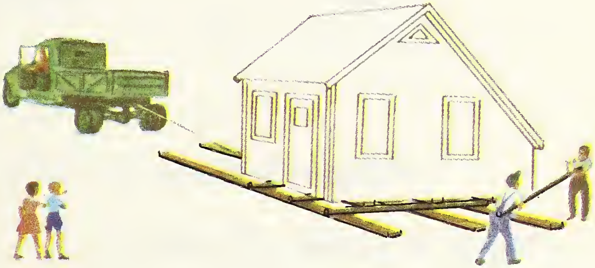


Moving a House

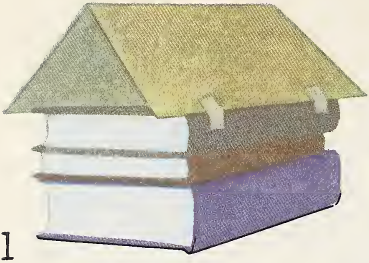
These men are moving a house.
They will move it to a new place.

First they lifted the house
and put pieces of wood under it.

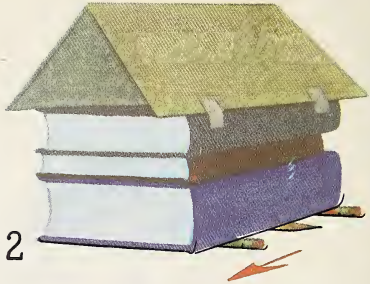
Then they put rollers
under the house.



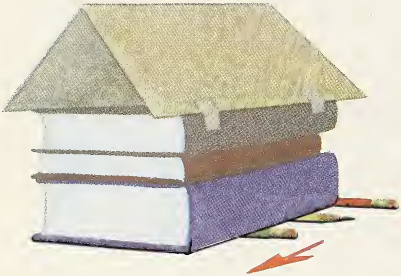
They fastened a truck to it.
The truck pulled the house along.



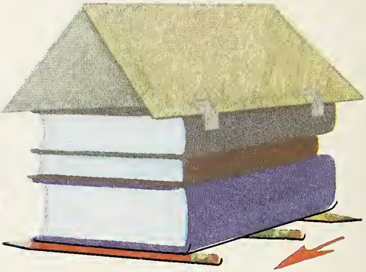
1



2



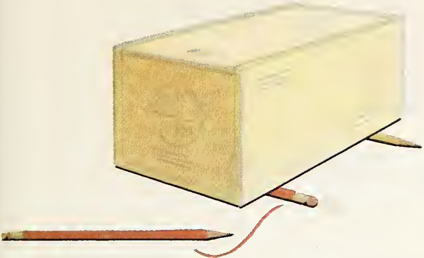
3



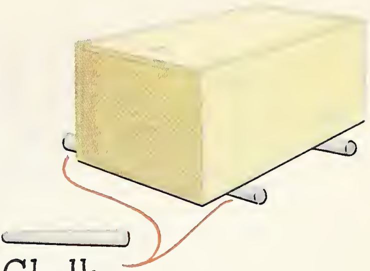
4

Using Rollers

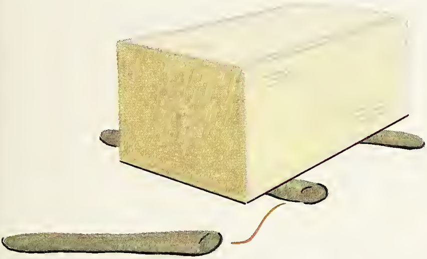
Make a house of books.
Use round pencils for rollers.
Rollers come out at the back.
What can you do with them?



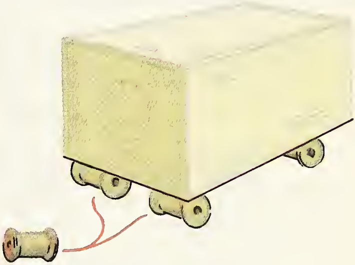
Pencil



Chalk



Clay.



Spools

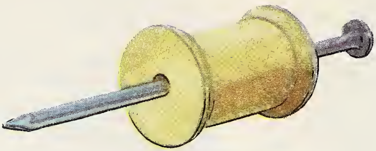
Move a box with rollers.

Try pencils that are not round.

Try chalk for rollers.

Try clay for rollers.

Try spools for rollers.



A Toy Wagon

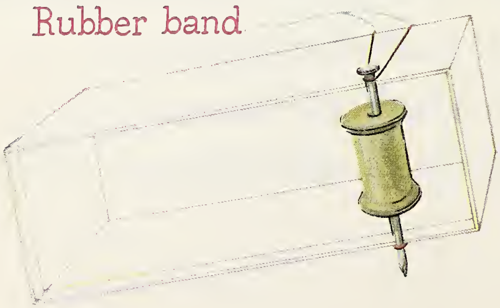
This wagon has rollers
that stay underneath.

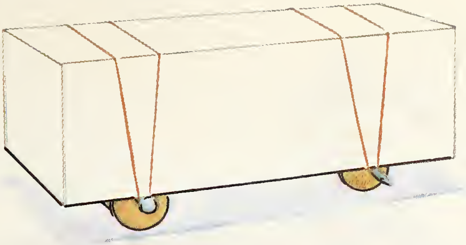
Push a big nail through a spool.

The nail will hold the spool
in place.

The spool becomes a wheel.

Fasten the wheel to a box
with a rubber band.





Find another spool
and another big nail.

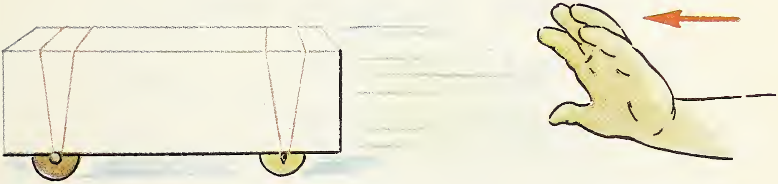
Fasten them to the other end
of the box.

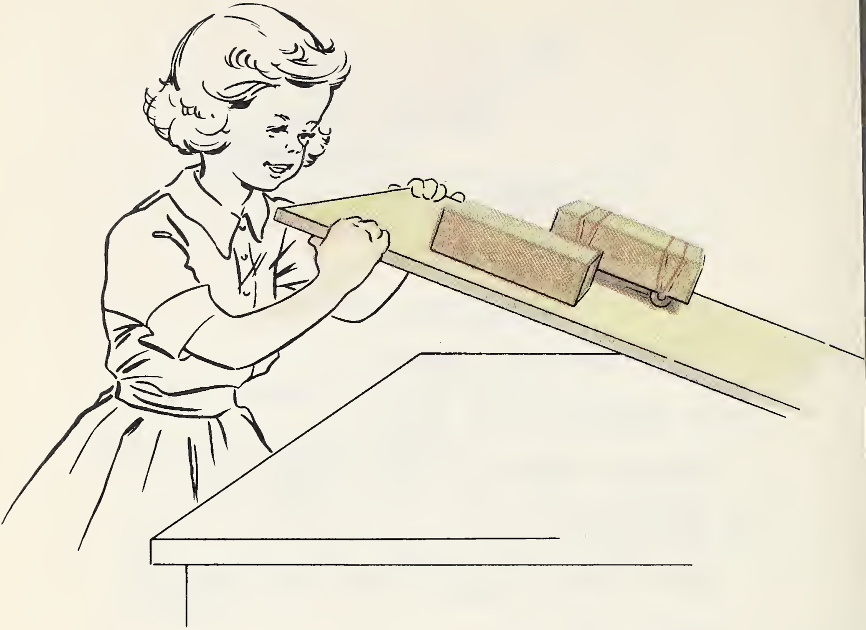
Now your wagon has two wheels.

Push the box.

Does it move easily?

Why are wheels
better than rollers?





Experimenting with the Wagon

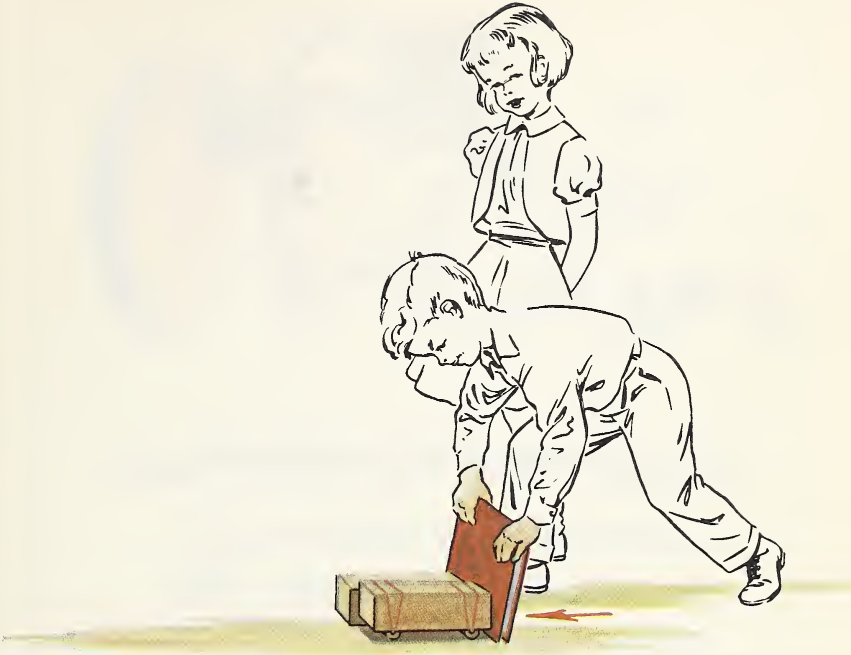
Put a box with wheels on a board.

Put a box without wheels on it too.

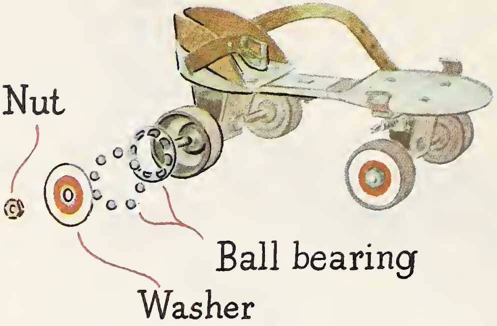
Lift up one end of the board.

Which box moves first?

Which box moves faster?



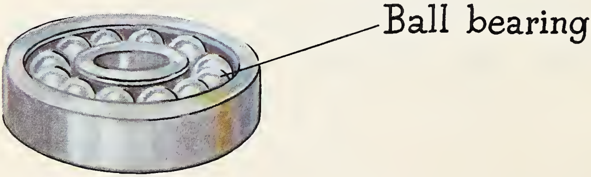
Put the same boxes on the floor.
Push the boxes with a book.
Which box moves farther?
Tell why wheels are useful.

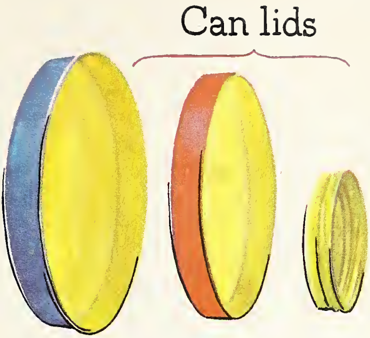


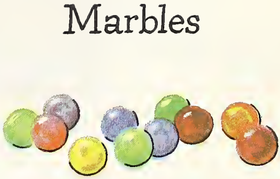
Making Wheels Turn More Easily

Look at a roller skate wheel.
The wheel turns on little balls.
These balls are part
of a ball bearing.

Many wagons have ball bearings.
Bicycles have ball bearings.
Look for toys with ball bearings.





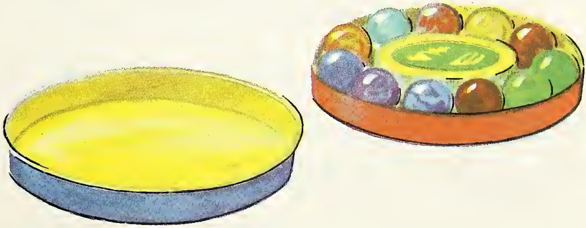


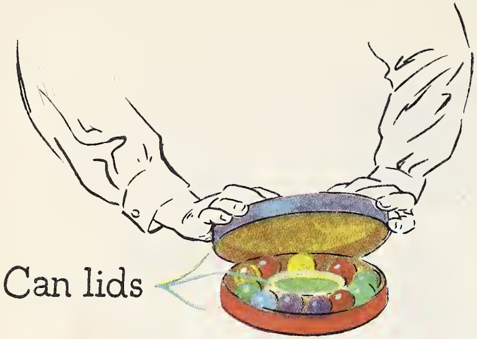
Making a Ball Bearing

Find the lids of three cans.
One must be a large lid.
One must be a little smaller.
One must be much smaller.

Put the smallest lid
in the red lid.

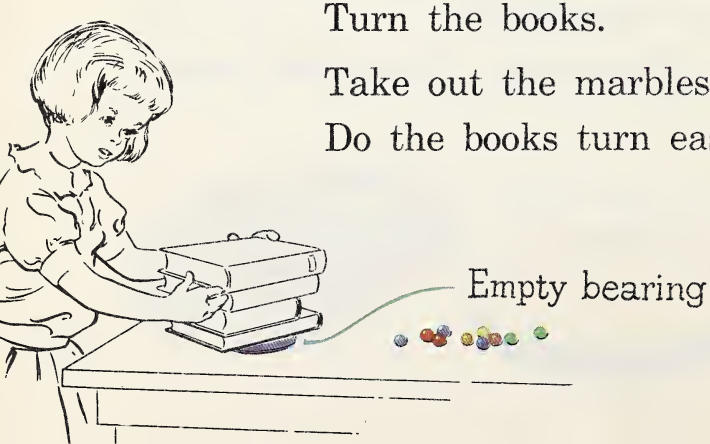
Put a ring of marbles inside.



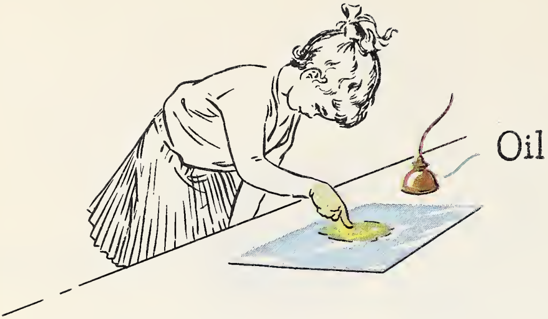


Put the blue lid
over the marbles.
Try the bearing.

Put some books
on the bearing.
Turn the books.
Take out the marbles.
Do the books turn easily?



Put the ball bearing on the floor.
Stand on the ball bearing.
Can you turn easily on it.
Try it without marbles inside it.



Oil for Bearings

Rub your finger
on a piece of glass.

Put a drop of oil on the glass.
Rub the glass again.

What does the oil do?

Put some oil on your bearing.

Does it turn more easily?

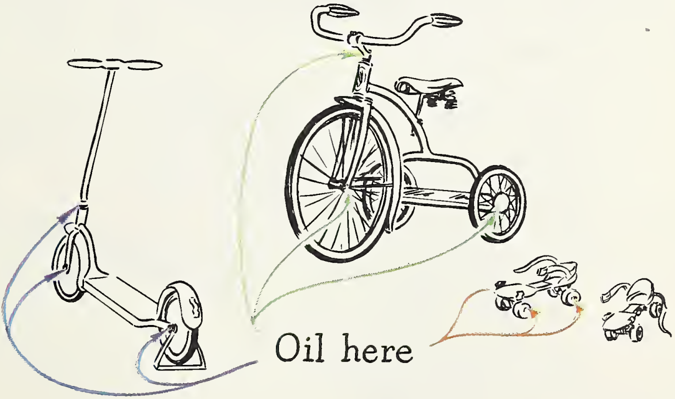
Put oil on the bearings of your toys.

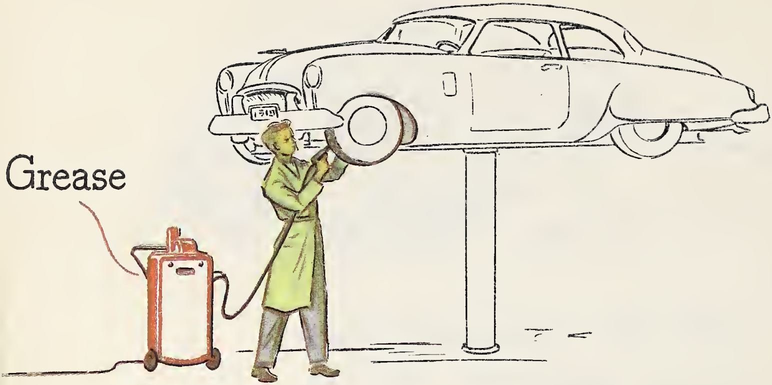
Then they will turn more easily.

Oil keeps bearings from wearing so fast.

Bring some toys to school.

Show where they should be oiled.





What is this man doing?
Do you know why he is doing it?

---

1. What are rollers used for?
2. Why are wheels better than rollers?
3. What are ball bearings?
4. Name some things that have ball bearings.
5. Why do we put oil on bearings?

Birds' Eggs

Two Robins Raise a Family

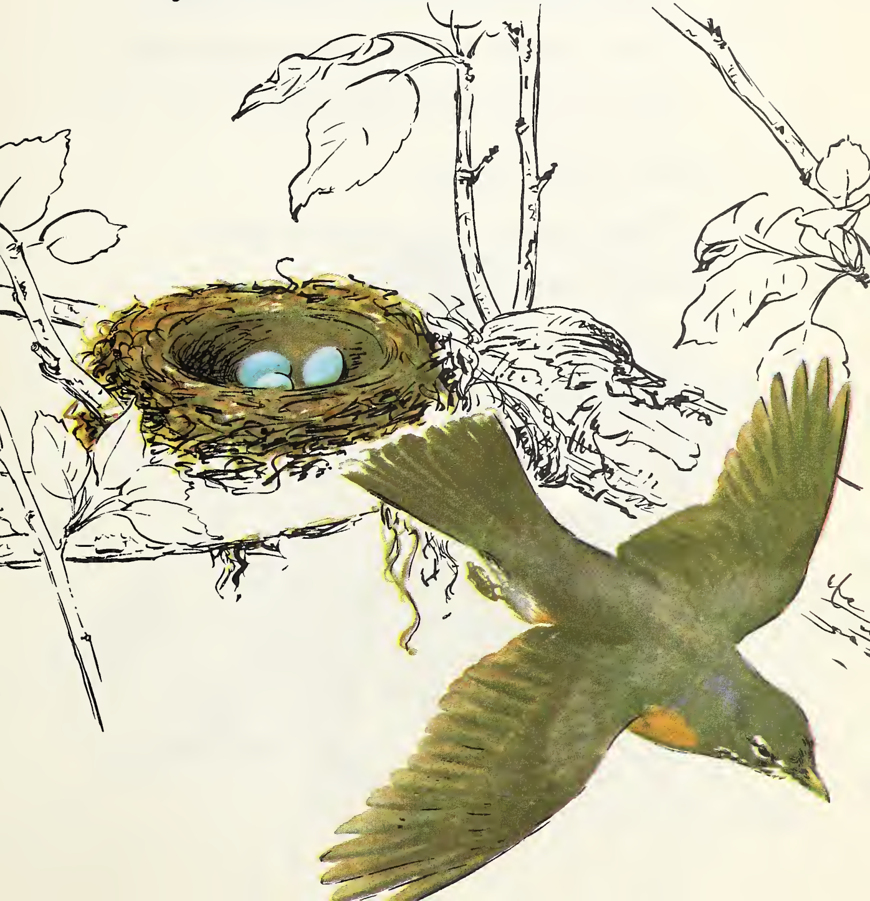
Robins make a nest in the spring.
They use small roots and grass.
They put mud inside the nest.
Where can they find roots?
Where can they find mud?

The mother robin lays eggs.

How many eggs are there in the nest?

What colour are the eggs?

What might happen if you went near the nest?

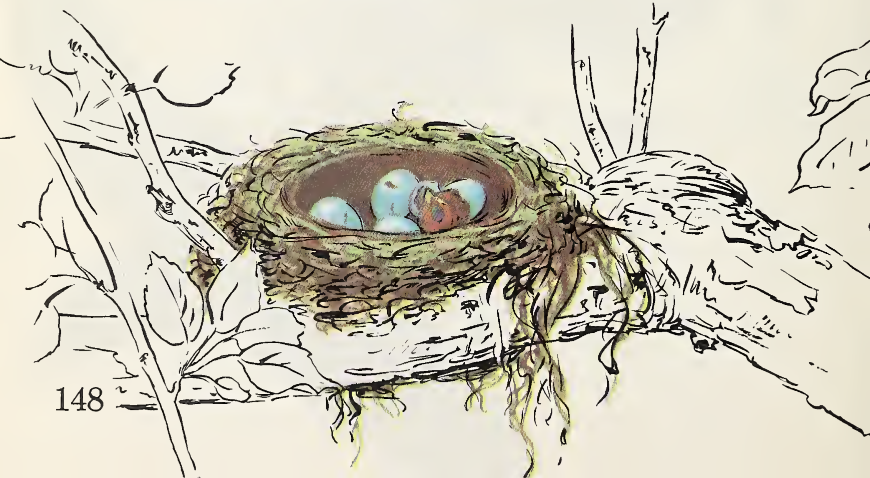


The mother sits on the eggs.
She keeps them warm and dry.

Sometimes the father sits on the eggs.

They keep the eggs warm about ten days.

Then what happens?
Look at the pictures.



The eggshells break.
The baby birds come out.

The baby birds have no feathers.
They cannot keep themselves warm.
They cannot fly.
They cannot feed themselves.

What do the mother bird
and the father bird do?

Two Ducks Raise a Family

The mother duck builds her nest
on the ground.

She lays her eggs in the nest.

Then she sits on the eggs
and keeps them warm and dry.

She sits on them about four weeks.

Then the eggshells break.
The baby ducks come out.

They have feathers.
They can walk. They can swim.
They can find food.

The mother duck keeps them warm at night.

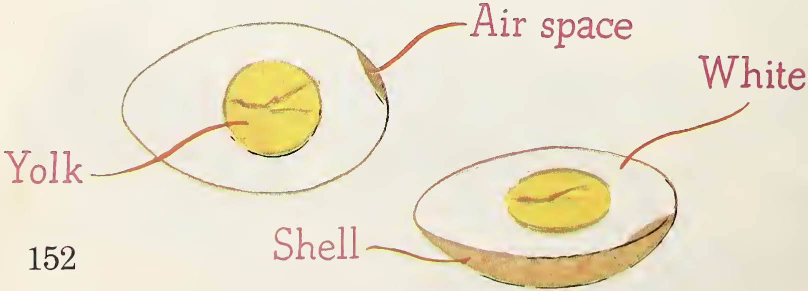
She helps them find food.
She tries to hide them from danger.

1

2

What Is in an Egg?

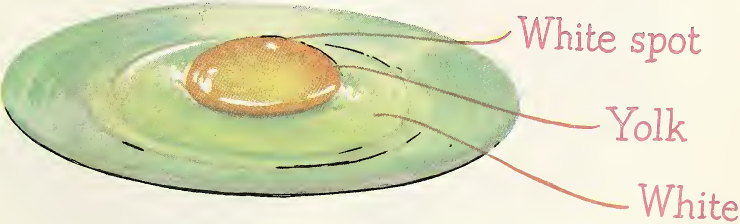
Hens are birds too.
A hen's egg is a bird's egg.
Boil a hen's egg until it is hard.
Cut the egg in half the long way.
Look at this picture.
Find the same parts in your egg.

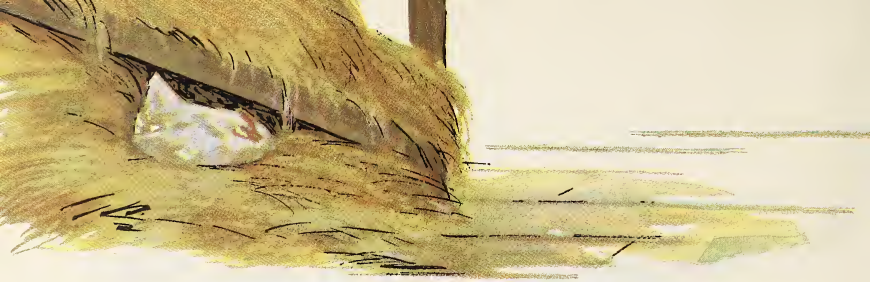


Break open another egg.
Look at the different parts.

Find the white spot on the yolk.
This spot
can grow into a baby chicken.

All birds' eggs have these parts.



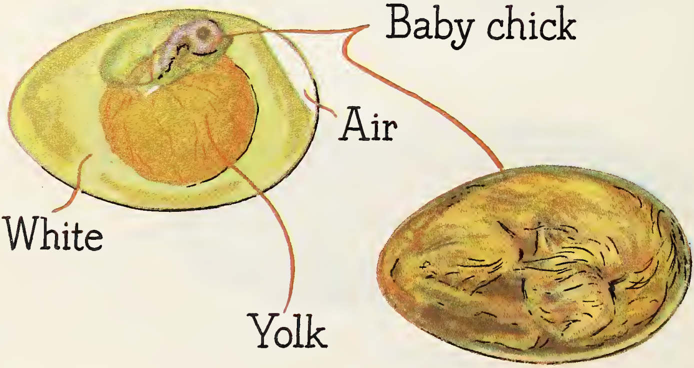


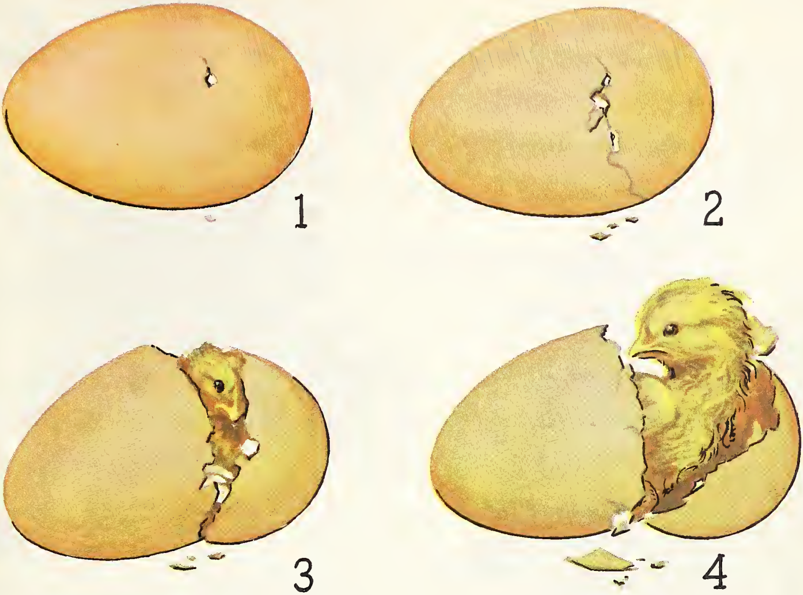
The mother hen sits on her eggs.
She keeps them warm.

The little white spot
begins to grow.

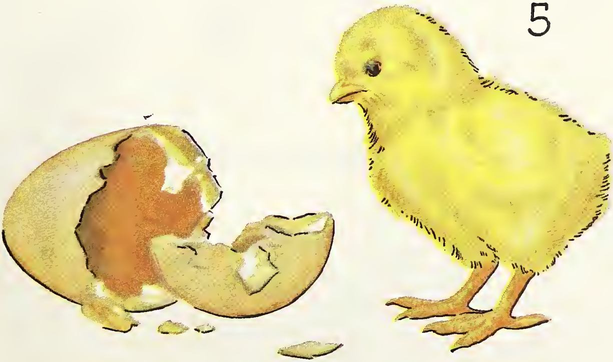
The rest of the egg
is food for the chicken.

The chicken grows
for about three weeks.
Then it makes a hole in the shell.



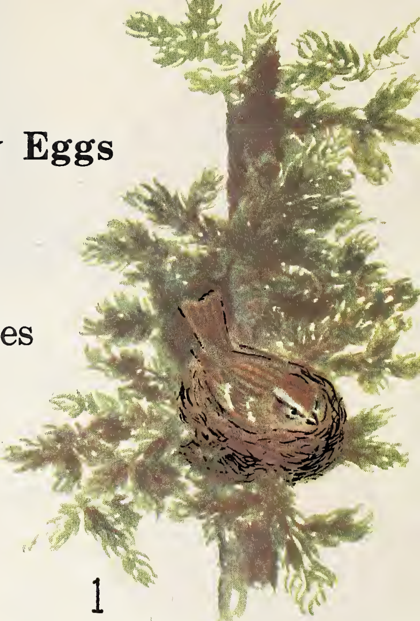


This is how the chicken hatches.



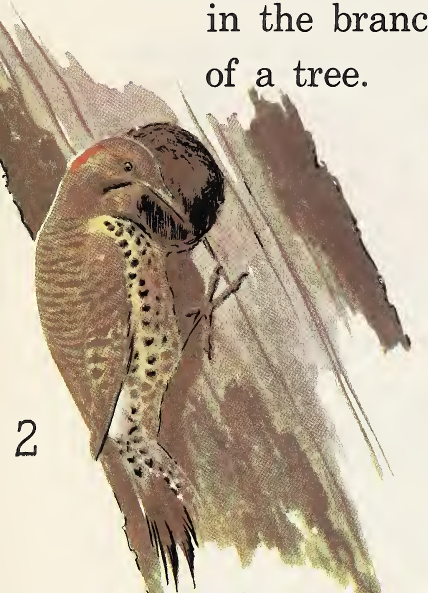
Where Birds Lay Eggs

This bird
makes a nest
in the branches
of a tree.



1

chipping sparrow

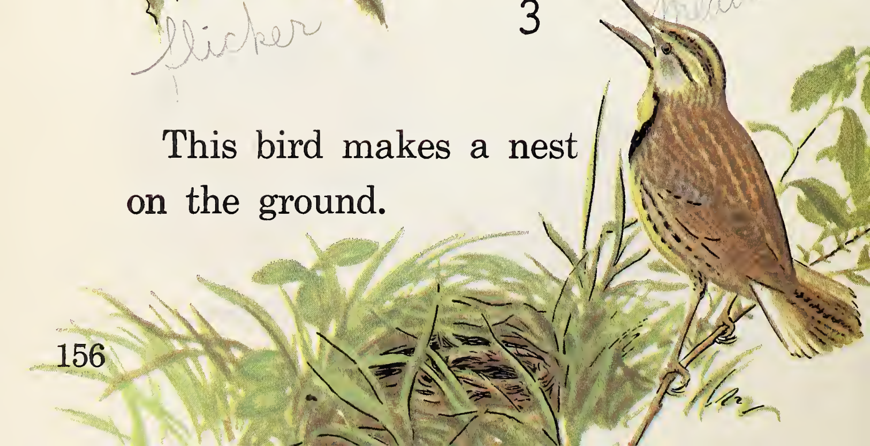


2

This bird makes
a hole in a tree
for a nest.

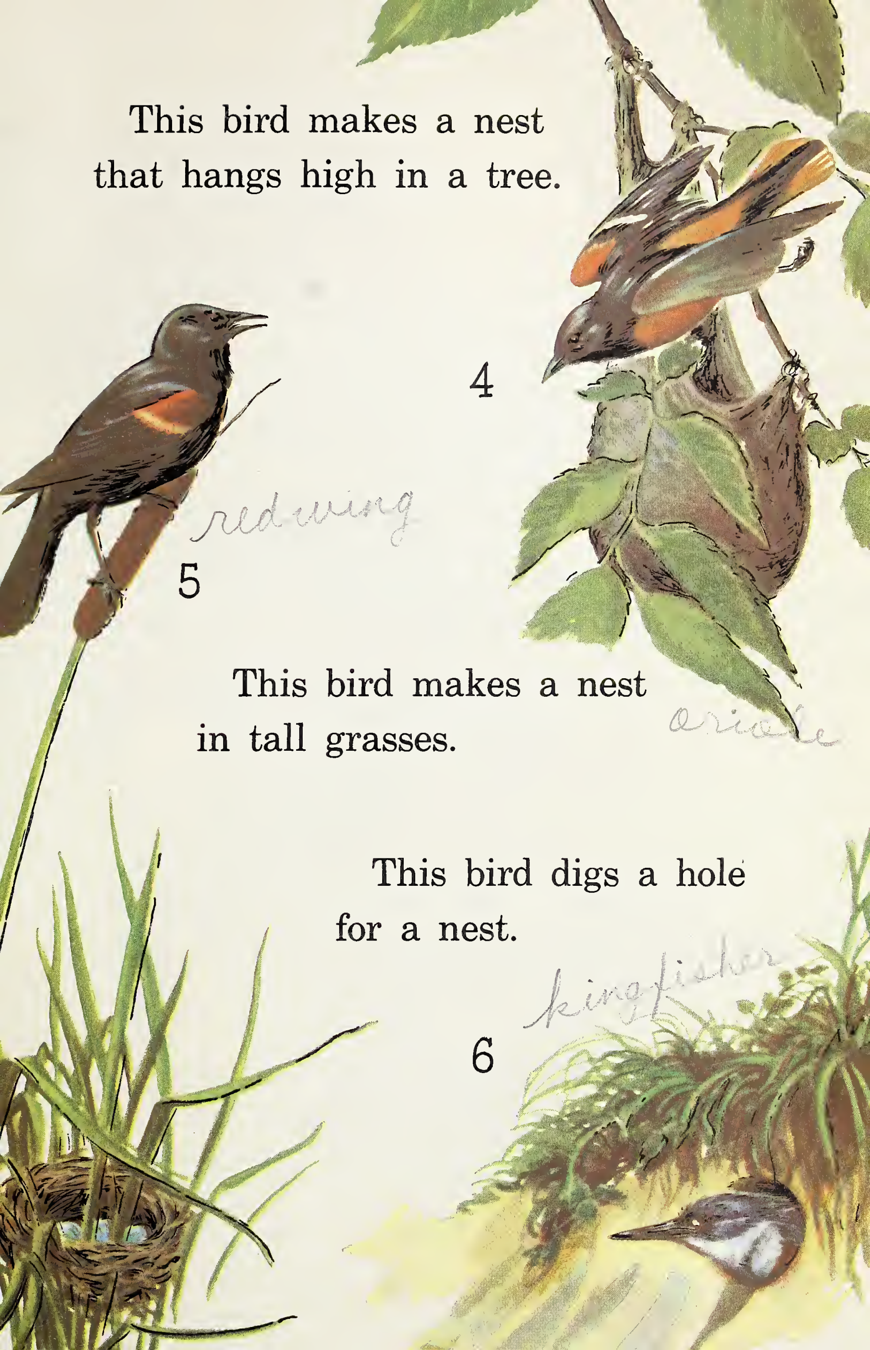
flicker

3



meadowlark

This bird makes a nest
on the ground.



This bird makes a nest
that hangs high in a tree.

4

redwing

5

This bird makes a nest
in tall grasses.

oriole

This bird digs a hole
for a nest.

kingfisher

6

This bird
may build a nest
in a bird house.

---

1. Where are some places
birds lay eggs?

2. What are the parts of an egg?

3. How does the mother bird
keep the eggs warm?

4. Name a bird that can walk
when it comes from the egg.

5. Name a bird that cannot walk
when it comes from the egg.

6. How does a baby bird
get out of an egg?

7. Where do eggs come from?

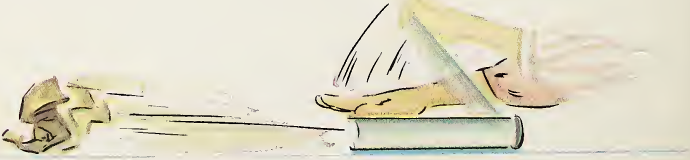
Wind

What Is Wind?

Open a book and close it quickly.
Feel the wind on your face.

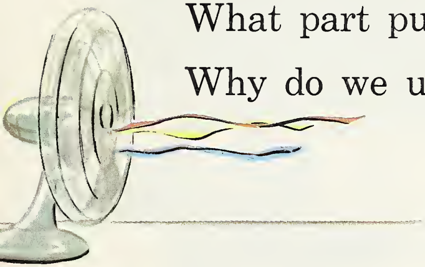
There is air all around the book.
The book cover pushes the air.
The moving air is wind.

Put a piece of paper
in front of a book.
Open the book and close it quickly.
What happens? Why?

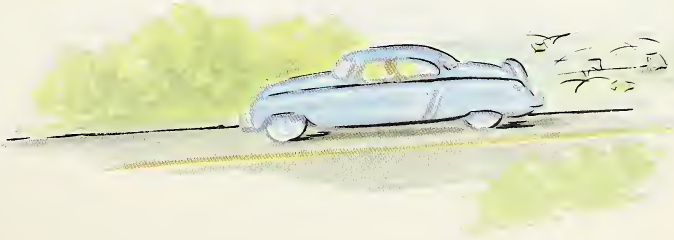


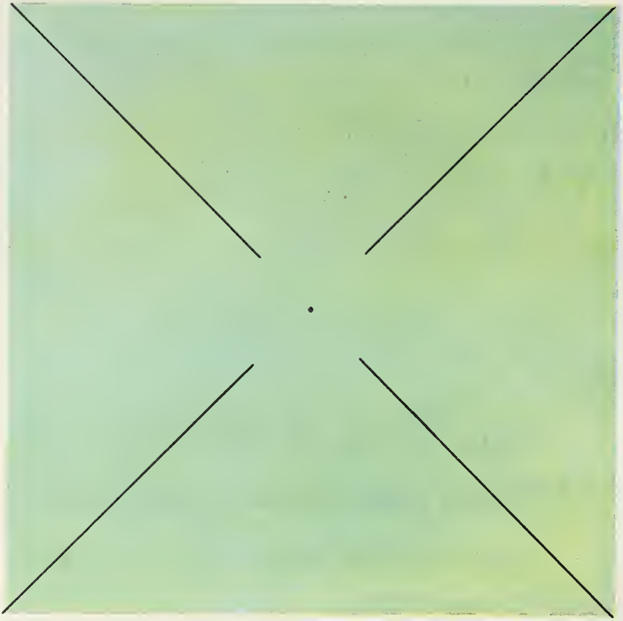
Make a fan
and fan yourself.
Tell why a fan
makes a wind.

Look at an electric fan.
What part pushes the air?
Why do we use electric fans?



There is a fan
in front of an automobile engine.
The fan helps keep the engine cool.
Ask someone to show it to you.





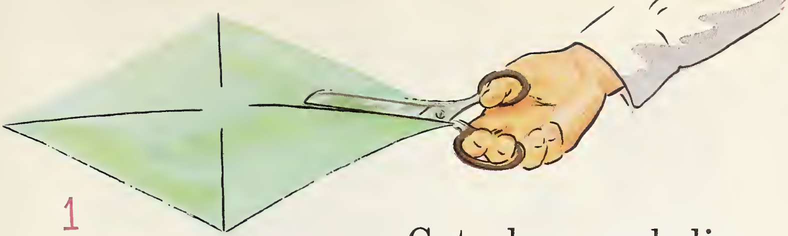
Making a Pinwheel

Cut out a piece of paper
like the one above.

Mark the paper the same way.

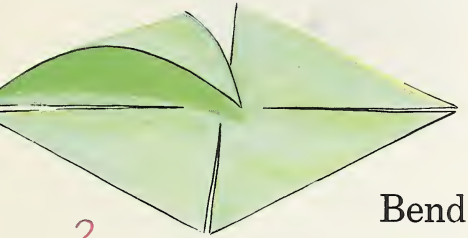
Look at the next page.

The next page
tells how to make a pinwheel.



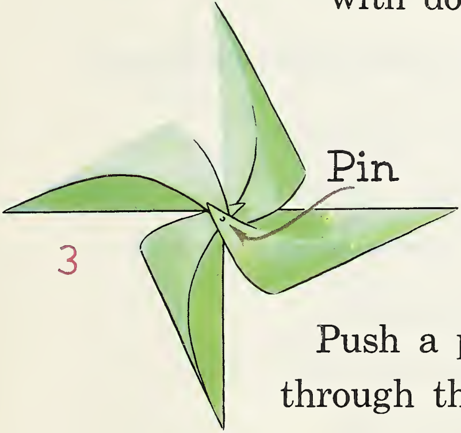
1

Cut along each line.



2

Bend over the corners
with dots on them.

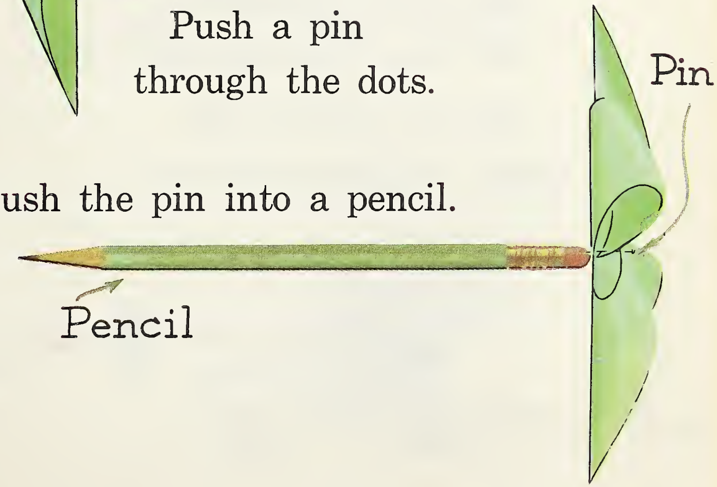


3

Push a pin
through the dots.

Push the pin into a pencil.

4

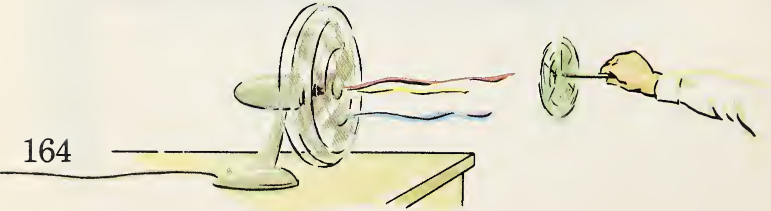


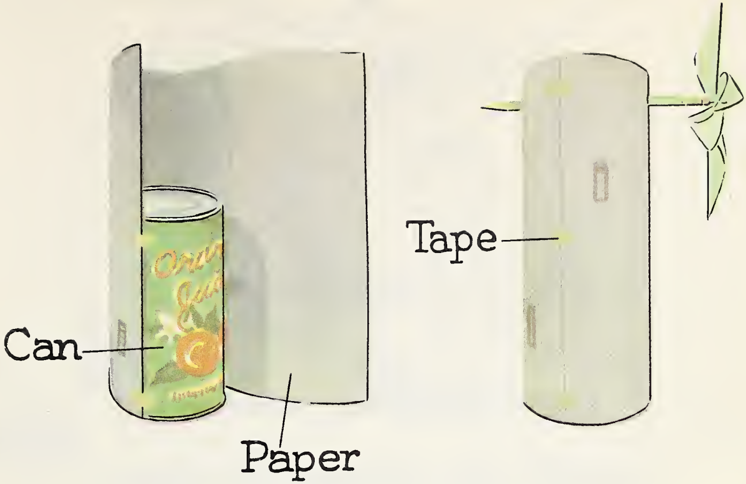
Experimenting with Your Pinwheel

Blow on your pinwheel.
What happens? Why?
What comes from your mouth?

Fan your pinwheel.
Tell why the pinwheel turns.

Will an electric fan
make the pinwheel turn?



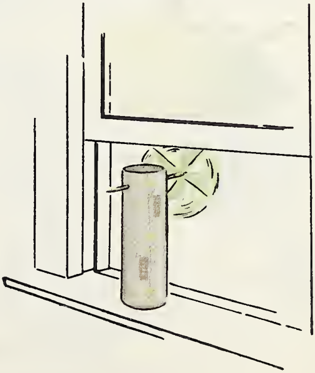


You can make a toy windmill with your pinwheel.

These pictures tell you how.

Put the windmill before an open window.

The wind will make it turn.



Experimenting with Wind

People say clothes dry faster in the wind. Is this so?

Dip two pieces of cloth in water.

Hang them on a line.

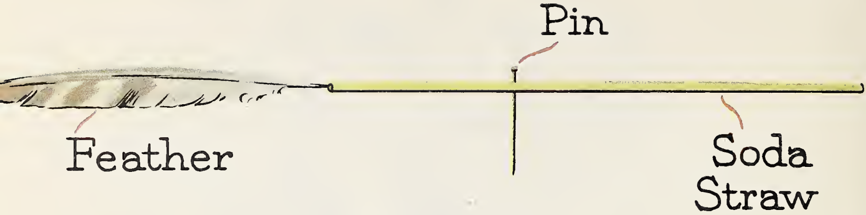
Blow air on one cloth with an electric fan.

Which cloth dries faster?

People say that wind cools things.
Is this so?

Use two cans of the same size.
Fill each can with hot water.
Take the temperature of each one.

Blow air on one can
with an electric fan.
Which cools faster?



Making a Wind Vane

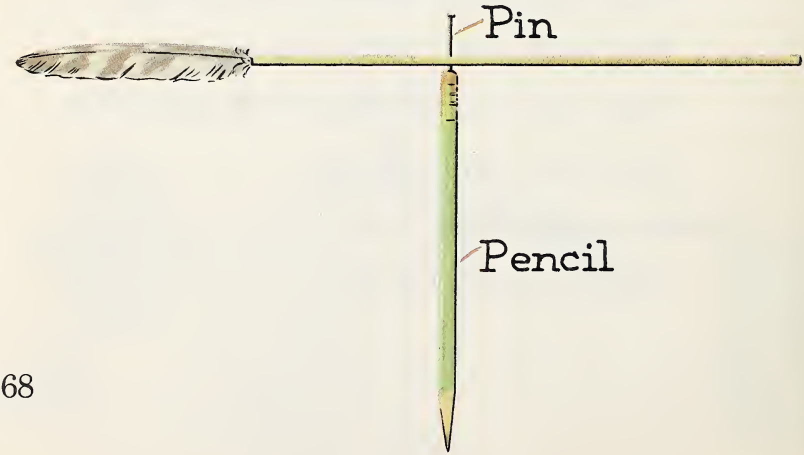
Push a pin through a soda straw.

Put a feather in one end of the soda straw.

Push the pin into the rubber of a pencil.

Blow on the feather.

What happens?



Tie your wind vane
to a long stick.
Push the stick into the ground.
Watch to see
which way the wind blows.

Winds and Weather

Sometimes the weather is very windy. People on farms do not like strong winds.

Strong winds blow down hay and corn. Winter winds pile snow across the roads.

Sometimes the wind
blows down big trees.
Sometimes the wind harms buildings.

Airplane pilots do not like
strong winds. Why? Who else
does not like strong winds?

The wind carries the seeds of many plants.

Name some plants that have their seeds carried by the wind.

---

1. What is wind?
2. How can we use the wind to help us?
3. How does the wind do harm?
4. How can you tell which way the wind blows?
5. How does the wind help plants and harm them?

The Major Topics
Presented in Each Unit

Unit 1 — Grasshoppers. How grasshoppers live. How grasshoppers can do harm. Animals that eat grasshoppers.

Unit 2 — Watching the Sky. How shadows change. How to find east and west. Clouds by day and night.

* **Unit 3 — The Thermometer.** How to read a thermometer. How a thermometer works. How thermometers are used.

* **Unit 4 — The Pull of the Earth.** Why things fall. How to measure the pull of the earth. How we use the pull of the earth. How the pull of the earth can harm us.

* **Unit 5 — When We Run and Play.** How we breathe when we exercise. How our hearts beat when we exercise. How blood goes through our bodies. What to do when we cut ourselves.

* **Unit 6 — Mirrors.** How light is reflected. How mirrors are used.

* **Unit 7 — Fun with a Dry Cell.** How to light an electric lamp. How to ring an electric bell. What electricity can do for us.

Unit 8 — Buds. What grows from buds. Some animals that eat buds.

Unit 9 — Rust. What kinds of things rust. What makes things rust. How to keep things from rusting.

Unit 10 — Moving Things More Easily. How rollers and wheels help us. How ball bearings help us. Why we put oil on bearings.

Unit 11 — Birds' Eggs. Where birds lay their eggs. How birds take care of their eggs. What happens inside an egg.

Unit 12 — Wind. What wind is. How we can make the air move. What the wind can do.

---

* These units include health and safety material.

Subject Index

The topics covered by *Exploring Science Two* have been indexed for the convenience of teachers who wish to refer quickly to specific subjects. Many of the references are to pictures, pictures having been used extensively in this second book to give information and directions for activities.

Words that are starred will be found in the reading material for the children. These words represent the special science vocabulary developed by *Exploring Science Two.* All other words used in the text have been checked against standard word lists for the second grade. A complete list of the words introduced in this book is included in the Teachers' Edition.

The opening unit of *Exploring Science Two* is equivalent to a standard primer in reading difficulty, while the remaining eleven units are on a first grade reading level.

air
  breathing, 66–67
  in egg, 152, 154
  temperatures, 33–45
* airplane, 19, 32, 171
antennae, insect, 7
arteries, 73
automobile
  cooling, 161
  greasing, 144
  mirror, 88
  thermometer, 48
* ball bearing, 138–143
barber's mirror, 89
blood
  human, 72–75
  chick embryo, 154
bluebird, 158
body temperature, 37, 46
* bones, 69
* breathing, 66–67
* buds, 103–116
  apple, 110
  aspen, 108
  cherry, 105
  elm, 103
  evergreen, 109
  forsythia, 104
  lemon, 113
  orange, 113
  peach, 112
  pussy willow, 108
chicken, 152–155
  hatching, 155

* clouds, 19, 26–29, 159
conifers, 109
cooling by wind, 167
* crickets, 17
crow, 14
cuts, care of, 75
* deer, 115
dentist's mirror, 88
derrick, 62
direction, 22–23
doctor, 69
doll house, 98–99
* dry cell, 91–99, 102
drying by wind, 166
duck, 150–151
* earth, pull of, 49–64
* east, 22–23
eggs
  bird, 145–158
  grasshopper, 10–11
electric bell, 96–97
* electricity, 91–102
electric lamps, 91–95, 98–102
embryo, chick, 152–155
* evergreen, 109
exercise, 65–76
fan, 160–161, 166–167
* flashlight, 102
flicker, 156
fox, 14
friction, 129–144
grass, 8
* grasshopper, 4–18
  as food, 14–15
  cage, 8
  damage by, 9
  eyes, 7
  food for, 8–9
  legs, 6
  skin, 13
gravity, 49–64
grouse, 114
hawk, 15
health, 44–47, 65–76, 166–167
* heart, 68–73
heat
  from electricity, 101
  from sunshine, 41
  removed by wind, 167
hen, 154
insects, 4–18
* iron, 117–128
katydid, 18
kingfisher, 157
knife, 118–119
leaves, 106–113
light, 19–31, 77–95, 98–102
lilacs, 106–107
liquids, pouring, 55
loader for trucks, 63
machines for lifting, 62–63
* magnet, 125
meadowlark, 156
* mirror, 77–90
* moon, 30–31
mouse, 15
nest, bird, 145–151, 154–158
nymphs, grasshopper, 11–12
* oil
  for bearings, 142–144
  to stop rusting, 126–127
oriole, 157
* paint, 128
pinwheel, 162–165
potato, 116

praying mantis, 18
pulse, 73
rabbit, 115
rain, 29, 119, 122–123
redwing blackbird, 157
* reflections, 77–90
rest, 76
robin, 145–149
* rollers, 130–137
roller skates, 138
rolling downhill, 52, 136
* rust, 117–128
safety, 56–57, 74–75, 90, 100–101, 118
* scales
  of buds, 107
  for weighing, 59, 61
seed dispersal, 172
seesaw, 64
shadows, 19–21, 24–28, 41
shell of egg, 152–155
sign, warning, 90
skunk, 15
* sky, 19–32
sliding downhill, 53–54, 136
snake, 15
* snow, 170
snow loader, 63
sound, 96–97, 100
sparrow, 156
stethoscope, 69–71
storm, 170–171
sun, 19–29
sundial, 24
* temperature, 33–48, 167
  in an aquarium, 36
  of ice-water, 37
  records, 44–45
  in shadows, 41
  of soil, 40
  in sunshine, 41
  in wind, 167
* thermometer, 33–48, 167
toad, 15
tools, care of, 122–123, 127
truck, dump, 54
veins, 72–75
wagon, toy, 134–137
water
  reflections, 80–81
  and rust, 119–128
  temperatures, 36–37, 40, 43
* weather, 19–32, 33–45, 119, 122–123, 159, 168–172
weighing, 58–61
* west, 22–23
* wheels, 129–144
* white of egg, 152–154
wind, 26–27, 159–172
windmill, 159, 165
wind vane, 159, 168–169
* wire, 91–101
* yolk of egg, 152–154

Date Due

RENEWAL

'70

1 '78

DUE Educ FEB 7 '78 R

MAR 24 '78

RETURNED FEB 7 '78

MAR 31 '78

DUE Educ MAR 17 '78

MAR 17 RETURN

MAR 31 '78

NOV 13 RETURN

Educ DEC 2 '7

NOV 25 RETURN

DEC 7 RETURN

NOV 16 '72

NOV 23 '72 R

MAR 20 RETURN

DEC 5 RETURN

DEC 2 RETURN

JUN 3 RETURN

DUE Educ NOV 1 '77

Returned NOV 15 '77

ION LIBRARY
ICULUM

Q 163 T53 1957 V-2 TCH-ED-
THURBER WALTER A
EXPLORING SCIENCE/

39889541 CURR HIST

000021346366

EDUCATION
CURRICULUM

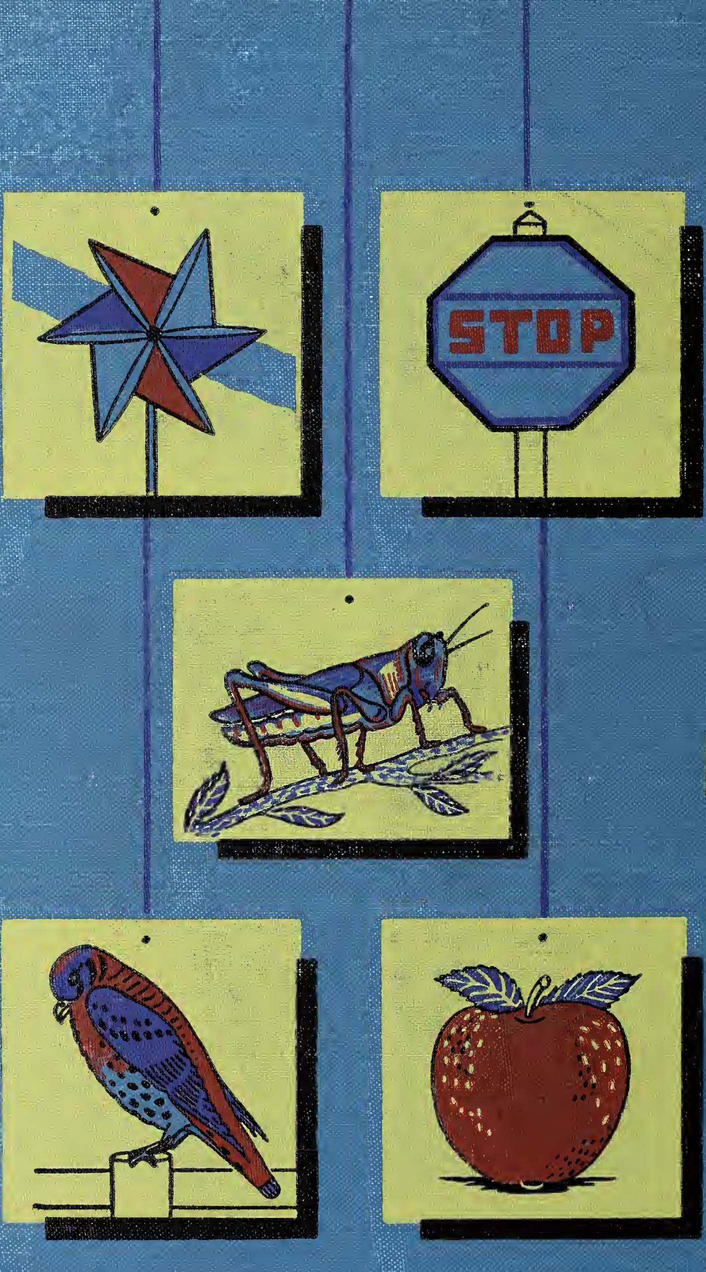
416347 HISTORICAL
COLLECTION
~~COMPACT STORAGE~~

Q 163 T53 1957 v.2 tch.ed.
Thurber, Walter A.
Exploring science /

39889541 CURR HIST

v.2
tch. ed.

CURRICULUM
EDUCATION LIBRARY


STOP